Baseline Report

On socio-economic and environmental factors regarding mountain spring source utilization and management in four sites of Dhankuta district, Koshi Province, Nepal.

META ICIMOD FutureWater

Roadside Spring Protection in the Himalayas (RoSPro)

March 2024

Baseline report

Executive Summary

Dhankuta is a mid-hill district in the eastern part of Nepal which is known for its richness in water resources including rivers and streams. However, there is a growing concern regarding the drying up of the spring sources impacting the livelihood of the residents in the region. Thus, this study encompasses various aspects such as the biophysical, socioeconomic and governance context of the selected four spring sources to address the challenges faced by the residents while managing the water resources for various purposes in the community. The main objective of this study is to secure the roadside spring sources with suitable intervention and at the same time reduce road damage due to the seeping of water from the spring sources and reduce its maintenance cost.

Before this study, a workshop with 34 representatives was organized in Dhankuta municipality for the selection of four spring sources, two springs from Dhankuta municipality and two springs from Chhathar Jorpati rural municipality. In each of the 4 selected springs, we conducted baseline data collection. The results of this baseline study as presented in this report are obtained through Focused Group Discussions (FGD) and Household Surveys (HHS) to gather both qualitative and quantitative data on various socio-economic aspects, springs and roads of the community. The HHS was conducted involving a total user population from each spring site i.e., 55 respondents. Alongside, one FGD in each spring site was conducted in the participation of 6-10 members from the spring user group of the community.

On aspects of demography, we found representation of diverse age groups and education profiles. The predominant source of income of the surveyed respondents is crop cultivation. This study also comprehends the respondents of diverse ethnic groups to promote equitable and culturally sensitive approaches. The average years of dependency of the surveyed household on the selected springs are found to be on average 20 years with 89% of the total HH currently relying on the spring water. The majority of the households collect the spring water through a direct pipe connection from the spring source and store the collected water in their drums, gagris[1] and various other vessels.

The majority of respondents report that the quantity of water in the selected springs has decreased at an average rate of 25-50% over the past years. The decreasing water in the spring poses various challenges in the daily life of the community people, where 31% of the respondents have shifted to alternative water sources in the surrounding area to meet the household water demand. The spring water is rarely reliable (4%) highlights various challenges being faced by the community members which indicates the significance of sustainable water management approaches in the community.

This study also sheds light on the significant changes in agricultural practices and environmental shifts over the decades in the region. The average land holding size of the respondents' farmers is reported to be 10 ropani[2]. With insufficient water availability for irrigating the agricultural field, farmers face challenges that greatly impact the agricultural productivity and livelihood of the community members.

The majority of the roads in the selected spring sites are constructed without the involvement of a technically skilled person and lack a proper drainage system resulting in an adverse impact on crop fields, houses and movement of vehicles, impeding the mobility of local community members. Further, this study highlights the active participation of community members in various activities and programs. Lastly, this

[1] A gagri is a name for a local vessel typically used to carry and store water.

[2] Ropani is a Nepalese customary unit of measurement which is equal to 5476 sq. feet

report recommends measures to address various challenges regarding the spring sources, road development and agricultural practices in the selected spring site.

Table of Contents

Contents

List of Figures

List of Tables

1. Introduction

Dhankuta is a mid-hill district situated in the eastern part of Nepal in the Koshi Zone. As per the population census 2078 B.S. (2021 A.D) the population of the district is 150,599 with an annual population change of -0.78% (2011-2021 A.D.) and covers an approximate area of 891 square kilometer. Geographically, it is situated between 26°53' to 27°19' north latitude and 87°8' to 88°33' east longitude and is located at 243 to 629 meters of elevation above sea level. Dhankuta district falls largely in the Nibuwa-Tankhuwa Watershed, which is rich in natural resources and supports over 80 species of flora and fauna. It also provides essential ecosystem services which shape the wellbeing of the people living in the watershed and downstream, including water for drinking and irrigation, fuelwood and other ecosystem services and contribute to local development.[3]

Water resources in Dhankuta district

There are several rivers and streams in Dhankuta district making it rich in water resources. Major rivers like Tamor, Arun, and Dudh Koshi travel through the district which offers an abundance of water to produce hydroelectricity. In addition, there is a high number of naturally occurring springs sources and waterfalls that add to the area's scenic appeal and draw tourists toward its natural beauty. These springs also have cultural significance for the residents of the community. Every year, a ritual is done near the Keshari Kharka spring, where they offer different foods like milk and rice, decorated with flowers. One of the community member Indra Karki does this ritual every year during Nagpanchami (a day of traditional worship of Nag or snakes observed by Hindus, Jains, and Buddhists throughout Nepal) and offer milk to the snake god and worship real snakes that come out from near the spring source and drink the offered milk. They worship the snake for blessings and protection of their families. Some other community members continue this ritual in absence or unavailability of him. Chanchala devi spring itself is named after the nearby temple, devi means God. Chanchala devi temple is the temple of God Shiva named as Chanchale Swor Mahadev. People in the community indicate that this temple is also mentioned in the Swasthani book. A Hindu book that tells the stories of various gods and goddesses, amongst others about Swasthani and Shiva.

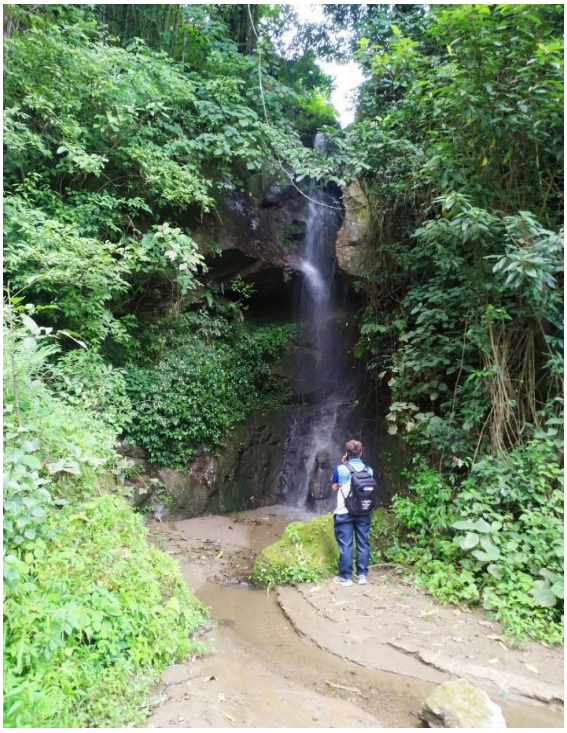


Figure 1: Waterfall (originated from spring) in Chanchala devi temple.

Dhankuta district is also well known for having numerous natural springs which are the product of groundwater seeping through porous rocks that emerge from the surface. There are many different possible origins for springs, where underground water typically flows along geological discontinuities or fractures in the rocks.

[3] Read more information about the Nibuwa-Tankhuwa watershed management plan here https://lib.icimod.org/record/35426#:~:text=This%20watershed%20management%20plan%20aims,of%20water%20in%20downstream%20regions.

In the mid-hill regions of Nepal, out of 13 million people, approximately 80% of the total population depends on spring sources as the primary sources of water to fulfill the water demands of residents[1]. The springs fulfill domestic, drinking, and agricultural water demands of both the urban and rural communities in the mid-hill region. Furthermore, springs play a significant role in maintaining the vegetation and wildlife as well as providing water for the base flow in rivers.

Dwindling spring water sources

Over the years, there is an increasing concern regarding depletion of spring sources. All over the Hindu-Kush Himalaya range this is an issue. Few studies have been made so far by USAID, NWCF, ICIMOD and IWMI on the status of springs in Nepal. The study by NWCF and ICIMOD in 2020 in 300 municipalities in the different parts of Nepal covering Churia, mid-hills and mountain region revealed that springs are drying due to three main factors i.e. anthropogenic activities, climate change and seismic events. The study found that springs are drying up in 74% of the municipalities. According to leaders from local government in 300 municipalities, major causes of drying springs are haphazard road and infrastructure construction, followed by earthquake, climate change, deforestation, and landslides. The study also found that drying of springs has different levels of impact on different sectors: 76 percent on drinking water, 36 percent on sanitation and hygiene, 35 percent on livestock feeding, and 50 percent on irrigation and other domestic uses. Another study was made through the support of USAID in five watersheds in the western part of Nepal. The study revealed that the flow from approx. 70.07% of springs (of 4,222 springs mapped) has decreased.

Figure 2: Roadside spring.

In Eastern Nepal the depletion of spring sources is also a pressing issue. In the Nibuwa-Tankhuwa Watershed a myriad of issues come to the fore that are part and parcel to this dire situation. A key issue is the decreasing water availability during dry seasons which is perceived to be impacted by declining discharge from springs and streams caused by both human and natural factors. In Dhankuta districts locals perceive the following factor to be influencing spring water availability. Climate change for instance is one factor, especially the erratic rainfall, changing seasonality patterns and increased temperatures. But human factors also play a big role, for example increasing number deep borewells in Dhankuta district leading to overexploitation of the water source, road infrastructure development changing flow patterns of sub-surface water; while at the same time demand for the same water has increased over time owing to population growth, and increased irrigation demand for farming. Also, erosion of topsoil and resulting sedimentation is mentioned as a factor.

Road infrastructure development

The rapid development of road networks in the region has exposed some of the spring sources which has affected its outflow, many times the rock that is cut during road construction changes the location of the spring's orifice. In short, this means a displacement of the spring outlet. In addition, during the road construction, the water-bearing strata are exposed causing the aquifers to leak. The spring that gets exposed during road construction depletes the aquifer system and places the fragile water supply of the area under threat. At the same time, a rock-cut can open up a new spring, however, since this is directly adjacent to the road this must be managed well to prevent seepage water from damaging the road. However, the intersection of springs and roads is not given sufficient attention and at present it causes more harm than good. An important issue is that roads have been constructed rapidly in the last 5 years especially, after the decentralization of government materialized in Nepal. Often, roads connecting rural communities with urban centers are constructed without involvement of a road engineer. The problems arise from here since road design does not consider sub-surface water flows, drainage patterns and the hydrogeological conditions among others. Leading to roads that have short longevity and catchments that are negatively affected.

Figure 3: Road damage by water.

Need for roadside spring management.

Dhankuta district is highly dependent on natural springs and streams for various purposes such as drinking, domestic, livestock and agriculture. However, the residents of Dhankuta district are currently facing a significant challenge in managing water due to the continuous drying condition of the natural springs as a result of various natural and anthropogenic factors.

To address these challenges and secure spring water availability while improving the adjacent road stretches, it is important to understand the current situation for the spring users specifically. Furthermore, the involvement of local community members and collaboration with governmental and non-governmental organizations in the region are essential for shaping the practical and sustainable solutions. This study is therefore a first step in evaluating the baseline conditions upon which we will start a co-design process with all stakeholders, resulting in the implementation of tailored solutions to connect springs and roads in a beneficial manner.

This baseline study is carried out in Dhankuta municipality and Chhathar Jorpati Rural Municipality (CJRM) to understand the biophysical, socioeconomic, and institutional context of the selected spring area. It also

involves an analysis of operational models around the springs, purposes of usage, changes and availability of water in the spring over time, road network, mobility, perspectives on road transport, spring-road interplay, land-use and climate changes.

The number of households dependent on the selected spring sources is around 12-15 households per spring site, with a total of 55 HHS surveyed. At each spring site the community experiences challenges with the quantity of water available in their spring. These challenges have directly impacted farm yield and the livelihood of the community people. The various factors mentioned for a decreasing discharge in the spring sources are road construction, changes in the climate and lack of initiatives for conservation of these water sources.

The principal beneficiaries of this research are the local residents of the area, Dhankuta Municipality, Chhathar Jorpati Rural Municipality, and the Department of Local Infrastructure (DoLI) which is responsible for directing all the infrastructure development activities in Nepal. This study encompasses four spring sources, two springs in Dhankuta municipality and two springs in Chhathar Jorpati rural municipality. Thus, the subsequent sections of this report present the objectives, methodology, findings, discussion/analysis, conclusion, and recommendations that have emerged from this study.

2. Methodology

The key objective of this baseline study is to:

- Capture benchmark data and information upon which intervention priorities can be selected. This part feeds into the design for pilot implementation.
- Providing a baseline-situation overview against which changes can be identified, thus pre- and post-intervention impact assessment.

The methodology employed in this study emphasizes pre-intervention data collection, enabling a comprehensive impact analysis of road-side spring protection measures to be implemented in selected spring sources within Dhankuta municipality and Chhathar Jorpati Rural Municipality. The process of selecting springs for the research study involved thorough exploration of the local area in collaboration with the local community. This exploration followed a specific trajectory along the spring shed and road, during which locations were recorded using GPS technology while noting remarks to gain a comprehensive understanding of the area layout. A mixed-method approach, incorporating both qualitative and quantitative tools, was conducted to comprehend the socio-economic and governance dimensions associated with each spring.

The research study encompasses four spring sources, two springs from ward number 1 of Dhankuta municipality and the other two springs from ward number 2 of Chhathar Jorpati Rural Municipality. The GPS location and the number of dependent HHs for each spring is presented in the table below:

Table 1: Selected spring site location and number of dependent HHs

S.N.	Name of Spring	Village/Tole	Ward number/ municipality	GPS Location		Number of spring dependent HHs
				Latitude	Longitude	
1	Chanchala Devi Spring	Okmalung village	1/DM	27.032134	87.325282	12
2	Bojhe Spring	Tin talae tol, Thing Tol		27.042137	87.322152	14
3	Keshari Kharka spring	Jorpati tole	2/CJRM	27.054722	87.3675	13
4	Dhoje Dhara Pani spring	Dhoje Dharapani tole		27.0541667	87.38	13

We deployed largely three different methods in the process for this baseline survey which included 1. a workshop and spring selection procedure, 2. Focused Group Discussions (FGDs), 3. Households Surveys (HHS) and 4. Key Informant Interview (KII). This combination of methods ensures a high level of participation of local stakeholders and allows us to gain insight in both quantitative and qualitative data.

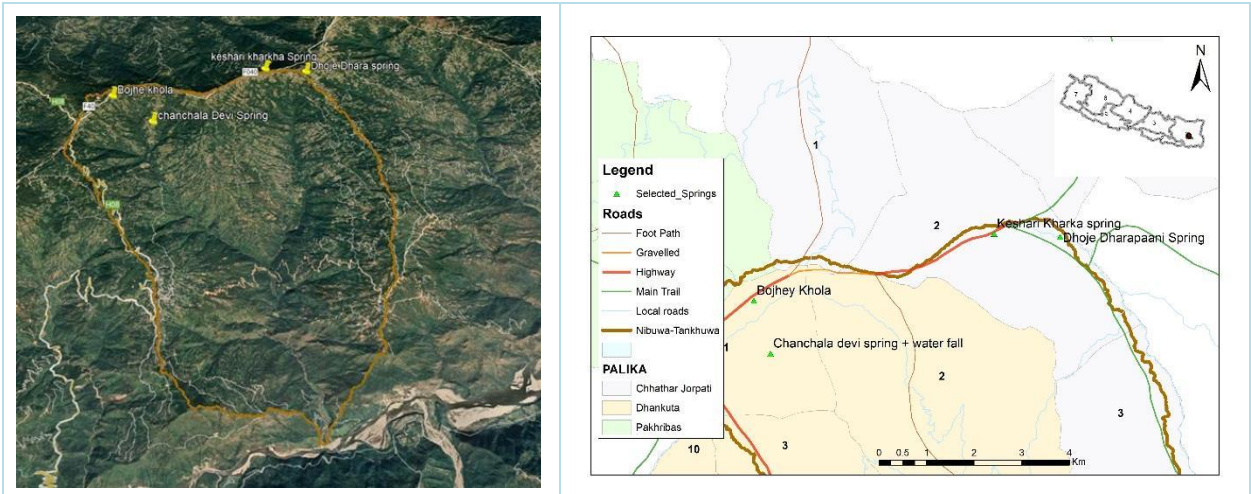


Figure 4: Location of 4 selected springs for piloting in NT watershed

1. Workshop and spring selection procedure

The selection process for the 4-spring source took place during a workshop in Dhankuta Municipality, Koshi Province, Nepal. A total of 34 participants, representing Dhankuta Municipality, Chhathar Jorpati Rural Municipality, Dhankuta district, and various government offices at the central and provincial levels, including the Department of Local Infrastructure (DoLI), Local Infrastructure Development Programme office (LIDPO) in Itahari, Koshi Basin office, Soil and Water Conservation office in Dhankuta, and the World Wildlife Fund (WWF), actively participated in the decision-making. The selection criteria for selecting 4 spring sites in the Nibuwa-Tankhuwa Watershed were determined prior and included:

1. High dependency on the source of water
   - Types of usage use, drinking, domestic or irrigation
   - Number of people/HH
2. Decreasing discharge in spring source
3. Impacted by road or impacting the road.
4. Plans for roadside construction / upgrading
5. Accessibility
6. Road location at feeder / agricultural road
7. Diversity in elevation (mid-hill, upper, etc.)
8. Willingness of the people to engage – ward members will express.
9. Potential for leveraging – other programs.
10. Choose 'simple' spring – not too big to work with (source / recharge area manageable)

Based on previous work and research, a pre-selection of springs was made by the RoSPro project team, after which each of these springs was presented and discussed in the workshop. From this discussion, the participants drew a priority list for the springs to be selected, which was then visited by the RoSPro project team together with the focal people from both municipalities. After the site visits, the final selection was proposed to the municipalities and approved.

2. Focused Group Discussion (FGD)

Focused Group discussions (FGD) combined with participatory mapping were carried out at each spring location to collect qualitative data from the spring users. In these group discussions, a cohort of 6-10 community members all using 1 of the 4 selected springs, was assembled to have a discussion around their knowledge, attitudes, local practices, perspectives, and perceptions concerning a range of issues such as water resources, road systems, climate changes, local resources, and biodiversity within the area. During these discussions, a participatory mapping exercise was undertaken, where community participants collaboratively drafted a map of their surroundings, highlighting key community features that formed the foundation of the base map. Such features include water sources, road networks, local biodiversity, and infrastructure. Features depicted on the base map were symbolized by specific symbols familiar to all participants, facilitating the group's orientation and comprehension of the final map. At the same time, the history of the place was talked about, for instance. For the existence of roads, for how long certain spring resources were used, since when did resources start depleting, etc.

The selection of participants for the discussion considered the following criteria:

- Ensuring equal participation of both male and female members from the user community.
- Focusing primarily on members currently utilizing spring water.
- Including participants from different age groups to gather comprehensive information regarding the water source, biodiversity, and infrastructure, allowing for insights into its history as well.

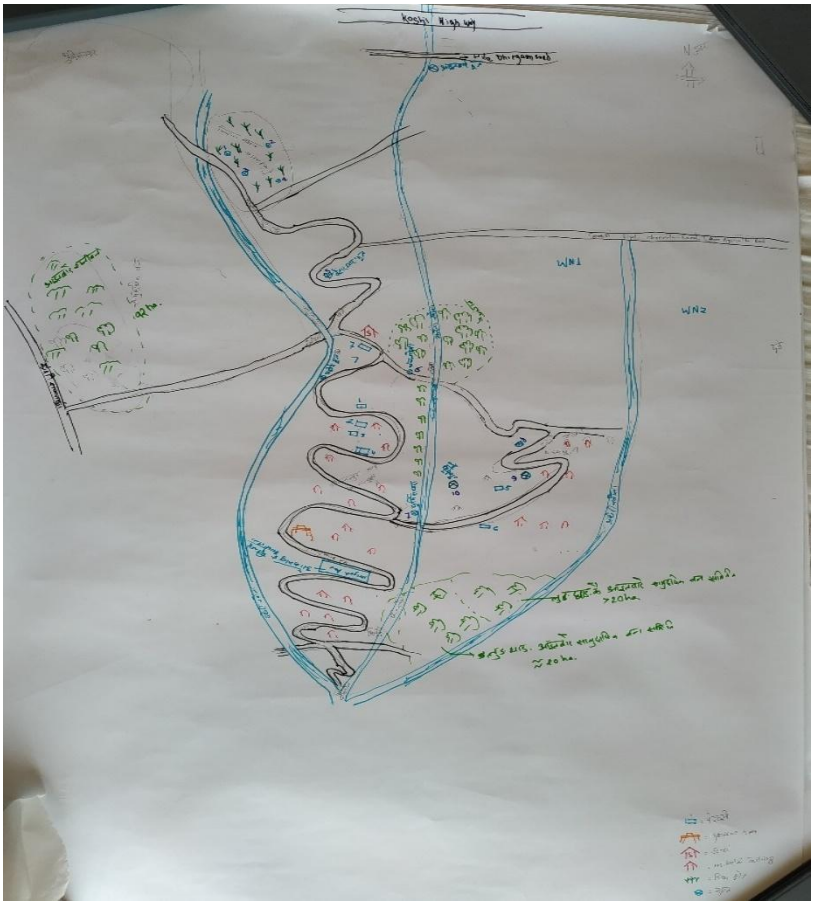


Figure 5: Participatory mapping during FGD in FGD in Chanchala Devi Spring.

3. Household Survey (HHS)

A Household Survey (HHS) is a research instrument comprising a series of questions designed to gather quantitative data from households concerning the utilization of the spring in the community. The primary objective of this survey was to collect relevant data on the community's use of the spring as a water source, including its accessibility, reliability, supply quantity, and its relation to road networks, accessibility, the impact of spring water on roads, or the impact of roads on springs, as well as considerations related to land use, climate, socio-cultural factors, and governance. For sampling, the entire user's population per spring site was included in the survey, given the relatively smaller number of spring-dependent households (12-15).

A carefully structured questionnaire was created and subsequently digitized using the KOBO Toolbox, an open-source platform designed for survey purposes. For data collection with the users in each of the communities, three enumerators were employed. One enumerator is part of the RoSPro project team living in Dhankuta, while the other two enumerators are from the communities themselves. All enumerators are perfectly versed in Nepali and understand the local customs and norms. Enumerators underwent a full-day training on the background and objectives of the project, conducting a pre-run of the survey questionnaires before initiating the surveys with spring users. After the first day of the Household Survey with spring users, an evaluation and feedback session took place to address any remaining issues and concerns.

The coming chapters will present the findings in the following chapters.

1) demographics and socio-economic context, 2) spring source usage and demand, 3) additional water sources, 4) agriculture, land-use, and climate change, 5) transport, mobility, and road network and 6) socio-cultural aspects and governance.

3. Demographics and socio-economic context

Figure 6 below shows the distribution of households that were surveyed for the HHS.

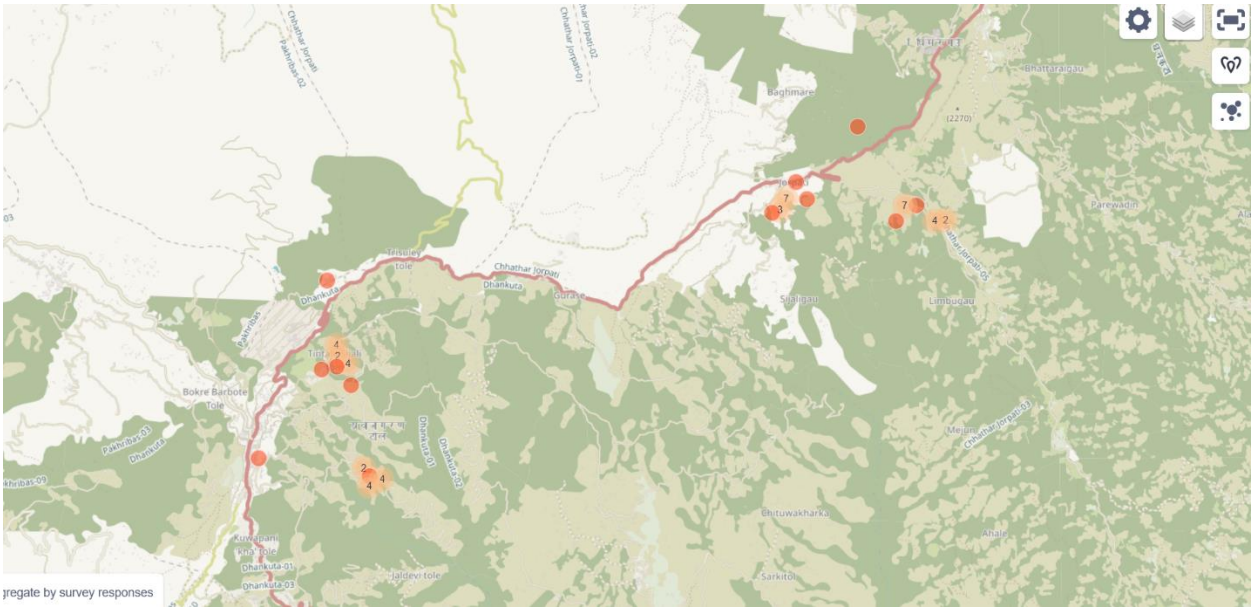


Figure 6: HH distribution in all selected spring sites.

The average household size among the respondents consists of 6 persons per HH which is greater than the average HH size in DM and CJRM (i.e. 4 persons per HH). Out of all the respondents 58% are female and 42% male. Though we aimed to achieve a 50/50 gender division, it occurred that more often women would be at the home, thus leading to a slight over presence of women. However, since there is only a slight difference and women are mostly the ones in charge of water management at the home, we deem the results of the survey are still highly representative for the overall spring users.

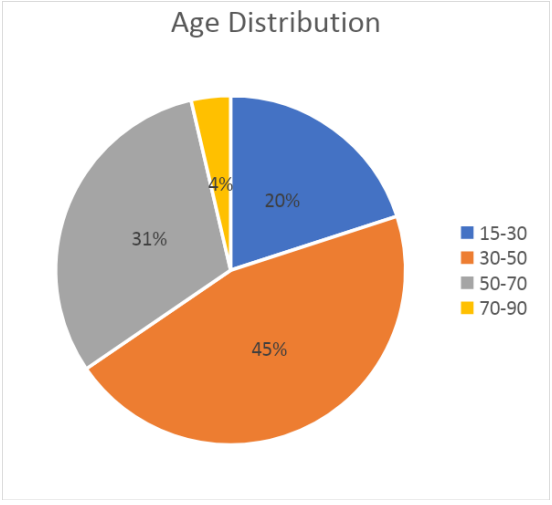


Figure 7: Age distribution of the respondents.

The age distribution spans across all age brackets, with the majority being between 30-50 years old, see figure 7. The respondents in the survey therefore are a representation of all different age groups ensuring a balanced representation of diverse perspectives.

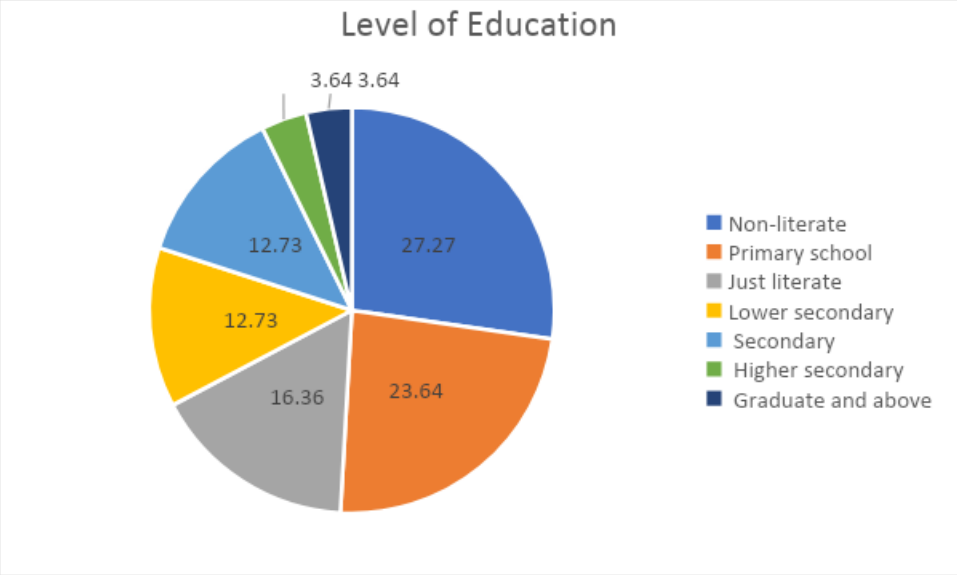


Figure 8: Education profile of the respondents.

The education profile of overall respondents represents a diverse range of educational backgrounds with the majority of respondents (27%) being non-literate. While a significant portion (16%) of the respondents were just literate with basic literacy skills such as reading and writing and numeracy skills. The literacy rate of overall surveyed respondents (i.e. 26 respondents out of 55) from Dhankuta Municipality (DM) is found to be 85% which is similar to the literacy rate of Dhankuta municipality, while for Chhathar Jorpati Rural municipality (CJRM), it is 62% in the surveyed area which is lower than the overall literacy rate of CJRM i.e. 81% as per the Nepal census 2078 B.S (2021 A.D)[4].

Table 2: Literacy rate per spring site

Spring site	Municipality	Literacy rate (%)
Chanchala Devi spring	Dhankuta	83
Bojhe spring	Dhankuta	86
Keshari Kharka spring	Chatthar Jorpati Rural	69
Dhoje Dhara Pani spring	Chatthar Jorpati Rural	56

[4] https://censusnepal.cbs.gov.np/results/literacy?province=1&district=7&municipality=3

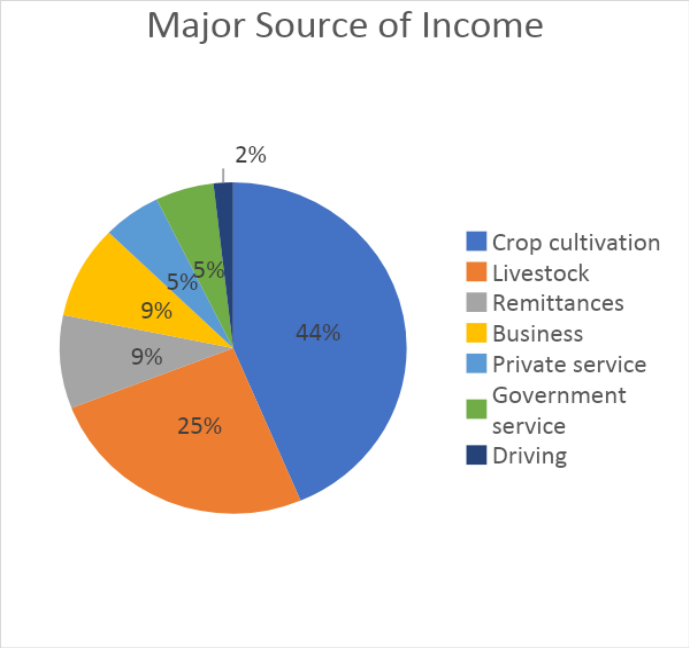


Figure 9: Major source of income among respondents.

The major sources of income for the respondents are farming, with crop cultivation (44%) being the most important, followed by livestock (26%). While 9% of respondents identified remittances and business as major sources of income. Additionally, private service, government service, and driving service were also mentioned. This highlights the economic dependency of community members on both traditional sectors (crop cultivation, livestock) and emerging sectors (remittances, business) for income generation. It also indicates a high dependency on farming-related activities, which are influenced by the availability of water from the spring sources. The table below shows the income sources for each spring site of survey.

Table 3: Major income sources per spring site

Spring site	Major Source of Income
Chanchala Devi Spring	- Crop cultivation: 100%. - Livestock: 83% - Remittance: 25% - private services: 25% - Government services: 8%
Bojhe Spring	- Crop cultivation: 100%. - Livestock: 100% - Remittance: 50% - Private services: 7% - Government services: 7%
Keshari Kharka Spring	- Crop cultivation: 62%. - Livestock: 31%

	- Business: 38% - Private services: 15% - Government services: 15% - Remittance: 31%
Dhoje Dhara Pani Spring	- Crop cultivation: 100%. - Remittance: 25% - Business: 6% - Private services: 13%

Figure 10 below represents the overall ethnic composition among the surveyed participants with higher percentage of ethnic group Magar and lower percentage of Dalit, Gurung and Yakha ethnic groups.

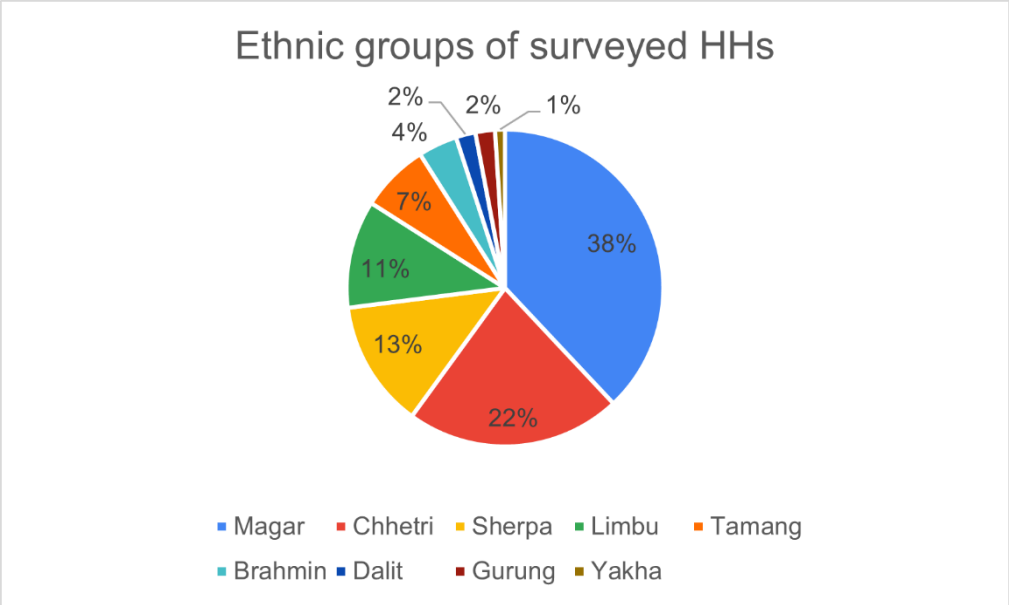


Figure 10: Ethnic composition of respondents.

The chart below illustrates the distribution of ethnic groups across different spring sites. It indicates a diverse range of ethnicities at Dhoje Dhara Pani and Keshari Kharkha spring sites both in CJRM, while Chanchala Devi and Bojhe spring sites in DM are characterized by bi-ethnic groups. Participants in the FGD consistently reported that there is no prejudice against individuals based on caste, religion, language, culture, or any other characteristic within the community. According to the participants, the community comes together without any discrimination whenever individuals require support in any situation. This sense of togetherness is considered the most beautiful aspect of the community.

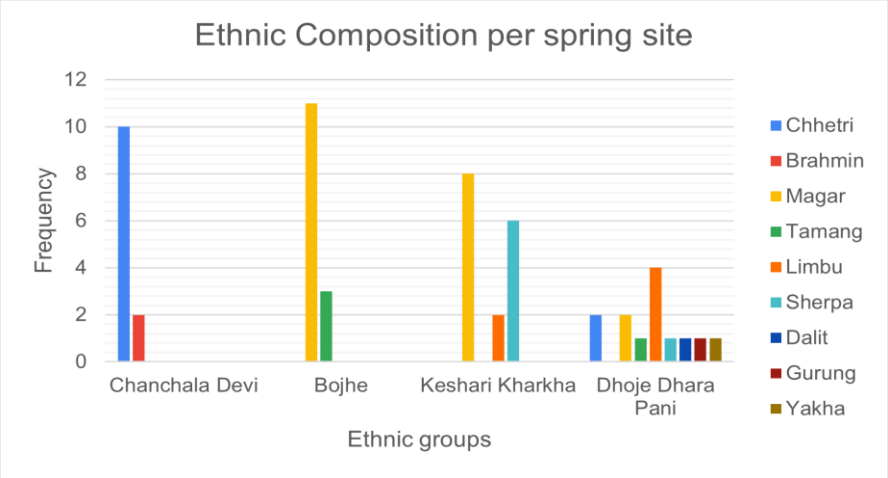


Figure 11: Ethnic composition of respondents per spring site.

Discussion:

From this information on the demographic and socio-economic context especially literacy rates and ethnic composition mark a difference between the four sites. As in Chhathar Jorpati Rural Municipality for both Keshari Kharkha and in particular Dhoje Dhara Pani, there is a larger variety of ethnic groups, and it's in these both locations as well where the literacy rates are clearly lower with 69% and 56% respectively. As compared to 83% and 86% for Chanchala Devi and Bojhe springs which are both located in Dhankuta municipality.

4. Spring source usage and demand.

The main purpose of collecting water from the springs is to fulfill the daily water needs of each household in the village, including drinking, domestic use, livestock care, and agricultural purposes. Out of the total households surveyed, 89% are currently dependent on spring water, while 11% do not rely on spring water now. For the 11% various factors, such as easy access to alternative water sources, the drying up of previous water sources, and insufficient quantity of water from the previous spring source, contribute to the shift to another spring source for water.

Table 4: Usage of spring sources

Spring site	Years of spring source usage	HHs using spring	HHs not using	Reasons for not using the spring currently
Chanchala Devi	30	10	2	insufficient water and easy to use seasonal springs in monsoon season*
Bojhe	50	14	0	
Keshari Kharkha	30	9	4	more water in the new source, tap water available at home/office. **
Dhoje Dhara Pani	16	16	0	

* A few HHs use both Chanchala devi spring as well as another seasonal spring for fulfilling their water needs. For these HHs Chanchala devi spring is normally used for drinking water, livestock, and domestic purposes. While the other seasonal spring is used to fulfill additional water needs for domestic, livestock and sometimes irrigation purposes. While 2 HHs from Chanchala Devi spring site have completely shifted to Baldhangray spring which is 450 meters far from the house. They mention that if the water in Chanchala Devi spring is increased, they will come back to use it back, as it is easier for them to use this spring.
** They mentioned that the new source with more water is at greater distance while Keshari Kharkha spring is nearer to the HH. So, if the spring is properly managed and if water quantity increases then they plan to use this spring again.

The condition of decreasing discharge and the increasing number of users near the selected spring sources results in insufficient availability of water to fulfill the water needs of all households. Due to this, some users are compelled to search and shift to other nearby water sources to meet their household water needs.

4.1 Water collection methods and management at the household

In most households, women are in-charge of fetching the water. If they are not available, men and kids assist in fetching it. Women are also in-charge of managing the water used for agriculture. Residents, typically, go fetch water twice a day i.e. one in the morning and another during the day.

Various methods are employed by the respondents for collecting water from the spring, as represented in *Figure 12* below. The majority of surveyed households (71%) use a direct pipe connection from the spring source for water collection. In that situation, the water from either a collection tank or the spring source directly, is taken to each household through pipes and it is collected in the drums which are set up outside the houses. From that drum the family member takes water in gagris and bottles to be used for drinking and domestic activities.

In the Chanchala Devi spring site, out of the 12 surveyed households, 2 were previous beneficiaries of spring water, while 6 households collect water from a drum near the house of community member Nar Bahadur Thapa. The drum, with a 1000-liter capacity, was provided by the Dhankuta municipality for water distribution in the village. The remaining 4 surveyed households collect water directly from a pipe connected to the spring source.

A notable portion of respondents (27%) employ a pipe connection from a collection tank for water collection, including households from Bojhe spring (Tin Talae Sinjali village). Users have constructed a collection tank with a capacity of 10,000 liters along the roadside, funded by the ward office and Dhankuta municipality office, initially provided at NPR 50,000. The remaining funds were later raised from user members. Two households near the spring site use a pipe connection to collect water directly from the spring. These households are situated above the road, making it challenging for water from the collection tank to reach them due to the higher elevation of their location compared to the collection tank.

The majority of users from both Dhoje Dhara Pani and Keshari Kharka spring sites use a pipe connection from the spring sources directly for collecting water.

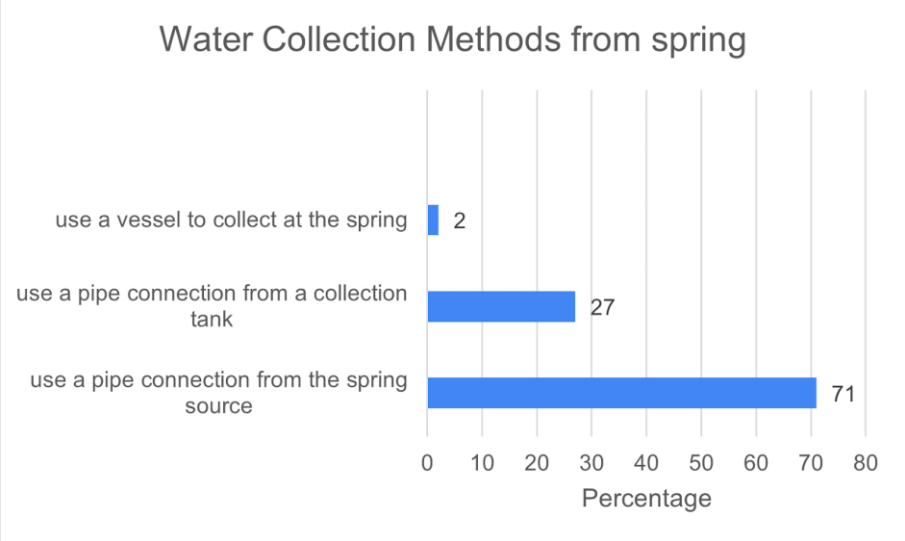


Figure 12: Water collection method.

Figure 13: Respondents from Bojhe spring site collecting water from a collection tank using pipe connection.

The respondent reported that the most common method of storing water at homes is in the drums with 71% of surveyed households employing these approaches. Gagris or similar vessels serve as another popular water storage method, with 62% of households. A noteworthy percentage (11%) indicates that some households do not store water; instead, they rely on a continuous flow and use spring water only when required.

The average size of drums among the surveyed HH is 950 liters capacity. It takes an average time of 208 minutes to fill the drum during the dry season while it takes an average of 165 minutes during wet season. The variation in the time to fill the drum of average 950-liter capacity during different seasons highlights the seasonal dynamics of water availability in the spring source.

A small percentage (5%) of households reported using alternative methods, such as ponds, for water storage and use it for agricultural use and livestock purposes. In Chanchala Devi spring site, some of the users have collected water in an unlined pond for irrigation purposes. While in the Dhoje Dhara Pani spring site there are 4 plastic ponds out of which only two are in use for agricultural use. One plastic pond is being used by 3-4 households and the water from the pond can be used for 3-4 days to irrigate small fields and nurseries only.

Figure 14: Unlined Pond in Chanchala Devi spring site.

Figure 15: Plastic lined Pond in Dhoje Dharapani spring site.

In Keshari Kharkha spring site, there are two ponds near the spring. These ponds (which also function as recharge ponds) receive water from Keshari Kharkha spring and rainwater water harvested from roof of CJRM building through pipe connections. Community members have been using the water from the ponds for irrigating a few nurseries, karesha bari, livestock purposes and in the development activities such as construction of buildings, roads etc.

Figure 16: Two ponds near the Keshari Kharkha spring.

Figure 17: Water stored *in drums and gagri in Keshari Kharkha spring.*

4.2 Changes in water quantity

The majority of respondents from Chanchala Devi, Bojhe, and Dhoje Dhara Pani springs reported a 50% decrease in discharge from the selected springs over the past 10 years. While the respondents from the Keshari Kharkha spring site reported a 25% decrease in discharge in the same period.

They attribute this decline to various factors including:

- Increasing Infrastructure development activities such as roads and other physical structures.
- Utilization of heavy machinery such as bulldozers, to cut away and shift rocks and soil is mentioned as a cause for the spring's recharge point to shift.
- Change in land-use pattern (i.e. the conversion of agricultural and grazing land into forest and settlement areas).
- Though also intensive agricultural use of upstream land is mentioned as a cause from decreased seepage/flow of water downstream into the rivers, as most of the water is used by crops.
- Specifically, the planting of trees and grass species that take up more water. Trees "Utish" Alnus nepalensis, "Masala" Eucalyptus, and grasses "Broom grass" Thysanolaena maxima and Dalae gash/Dallis grass Paspalum Dilatatum. It is said that higher density of these species abstracts more water from the soil and leaves less water to infiltrate and replenish sub-surface flow.
- Climate change impact, mainly increasing temperature, declining rainfall and irregular rainfall pattern/shifting of seasons.
- Increasing deep borewell work in the upstream area.
- Population growth causes higher abstraction of water.

Respondents from Bojhe and Keshari Kharka springs also mentioned that the 2015 earthquake (2072 B.S) might have contributed to this decline.

In the past, in Chanchala Devi Spring, there used to be three seasonal spring water sources near the Chanchala devi temple out of which one got dried up after the road construction. The two other water sources near the Chanchala Devi spring sources used to be sufficient for all domestic and agricultural purposes. However, in the last ten years, community concerns have experienced a drastic change in the quantity of water, a 60% decrease, while the quality of the water has improved compared to previous years due to increased community awareness of sanitation. As Everybody has an improved toilet in their home at the present time. The attribute to improve water quality is the visual observation from the community people.

In Bojhe spring people try to cope with the decreasing water sources by storing the water in a collection tank and opening the water for a certain time only for all. The water level is usually high during monsoon season and decreases during dry season.

People from Keshari Kharka indicate that over the past 10 years the sources of water in the spring have decreased by 25%, but they see a 2-5% increase in water level in the last year. According to them this may be due to proper management of the spring source as they have built a small intake near the spring for water collection.

Figure 18: Intake constructed by the community people around the spring source.

As of today, the spring water is enough for drinking, domestic and livestock purposes whereas farmers find difficulty managing water for irrigating the field. The water from the spring is only enough to irrigate nurseries and karesha bari. To irrigate large fields farmers, have to depend on rainwater. In the area there are two ponds near the spring that have direct connection with the spring for recharge and the rainwater from rural municipality office roofs is also harvested and diverted to the ponds through pipe connection.

People in the community have experienced a 40-50% decrease in water level of the Dhoje Dhara Pani spring source, while there is a perceived 20-30% decrease of water in other various spring water sources in the area.

Insight: the bigger picture around decreasing discharge, the example of Bojhe

The Bojhe spring users mentioned that in the past the water from the spring sources was also sufficient for transplanting rice. Rice cultivation requires a big amount of water, but at present farmers already struggle to irrigate other agricultural crops such as cereals and vegetables, while they abandon growing rice due to insufficient water. They used to grow rice in the past, i.e. more than a decade back. Furthermore, community people mention that in the past the water from upstream springs also used to seep through the ground surface into the Bojhe spring. However, at present water from upstream springs has been managed and taken to the Hile area (business hub for Dhankuta and surrounding districts) for supplying drinking water by the Dhankuta drinking water office. Due to this the flow of water in the spring has become smaller in Bojhe.

According to the local community, the population of Tin Talae Sinjali village that uses water from the Bojhe spring source, is steadily increasing due to the growth of family members. Currently, there's no significant migration in or out of the community. Traditionally, upon marriage, sons establish their own households and begin independent lives with the property inherited from their parents. With this transition, they also embark on separate agricultural endeavors. Many community members have turned to vegetable

cultivation, aiming to generate additional income to meet various needs such as schooling expenses and household essentials like rice and cooking oil.

The shift towards commercial vegetable farming began around 2008-2009 AD. This move was primarily motivated by several factors:

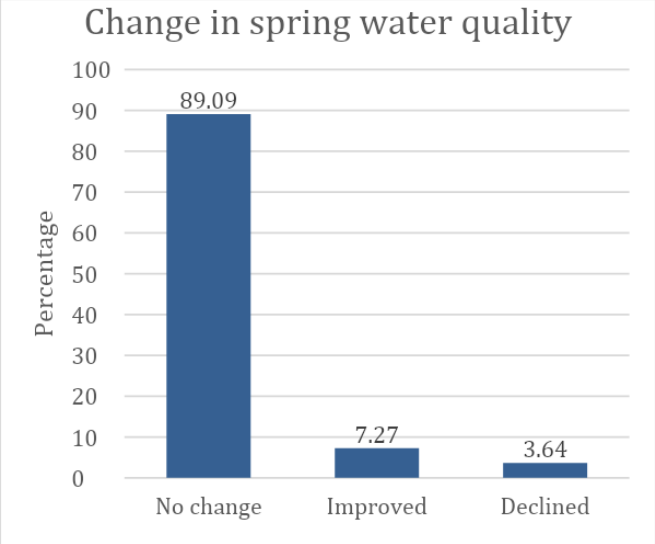
1. Market demand and value: Millet and maize, the staple crops previously grown, lacked consistent market value. Waiting for the weekly market (hatiya) often meant uncertain returns. In contrast, vegetables offer quicker turnaround and higher market demand.
2. Pest pressure: Maize and millet fields were increasingly vulnerable to attacks by monkeys, porcupines, deer, and rabbits, particularly over the past few years. Forest encroachment near the river has attracted these animals to agricultural areas. Commercial vegetable cultivation is less susceptible to such wildlife threats.
3. Climate challenges: The village faced drought in 2004/2005 AD, affecting maize crops due to late rainfall and rising temperatures. Similar weather patterns persist today, with delayed rainfall leading to reduced spring flows and heightened temperatures exacerbating soil moisture depletion.

Additionally, the proliferation of private forests and the rise in livestock ownership (2-3 livestock per household) have further strained water resources, impacting irrigation availability for vegetable cultivation. Despite these challenges, the community's transition to commercial vegetable farming reflects their adaptive response to economic and environmental changes.

4.3 Changes in water quality

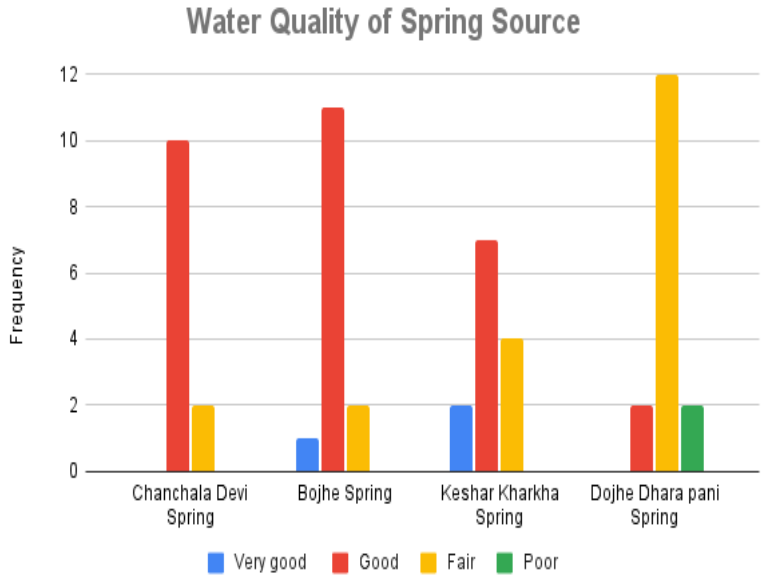
Among all surveyed respondent, 89% perceive that there is no change in term of *water quality* whereas 7% believe water quality has improved, attributed to:

- Environmental conservation efforts (e.g., afforestation).
- Conservation of spring source and surrounding area.
- Community initiatives like building rough wall structures to prevent sediment entry and reduce contamination.



4% of respondents note a decline in water quality attributed to increased construction of roads and buildings, and deep boring. Bojhe spring site respondents report issues in spring water quality during monsoon such as:

- Water smells muddy due to the presence of Bojho (Acorus calamus)[5] in the upstream side of the spring source.
- Color changes to red during heavy rainfall.



On the water quality issue, the perspective was different for different springs. In Chanchaladevi and Bojhe spring, about 85% of the respondents say water quality is good. In Keshari kharka, 70% said it is good and 30% said it is fair. But in Dhoje Dharapani spring, it is a mix bag of a response i.e. water quality ranges from good to poor, where 75% of respondents perceived water quality is fair and 7% said it is poor quality. This may be attributed to the road surface water intrusion to the spring area from the road upstream not far from it when it rains.

[5] Bojho (Acorus calamus) is a plant cultivated in tropical and subtropical regions and mainly its rhizome to cure many health disorders like throat inflammation, common cold, chest pain, bronchitis, whooping cough and to open the respiratory passages.

(a)

(b)

(c)

(d)

Figure 20: Spring source (a) Chanchaladevi Spring, (b) Bojhe Spring, (c) Keshari Kharkha Spring & (d) Dhoje Dharapani Spring

In the FGDs community members of different springs add that in the past the spring sources were not protected and conserved, while currently they cover the spring sources with iron sheets. This prevents the dirt and dry leaves from entering the source and prevents the interference of animals like dogs and monkeys in the spring water. They have experienced positive changes in water quality both in terms of smell and taste. Generally, people noticed that since they started cleaning and protecting the spring area and its surroundings, the quality of water has improved to some extent in terms of its turbidity, smell and taste. As of now they have not done any water quality testing.

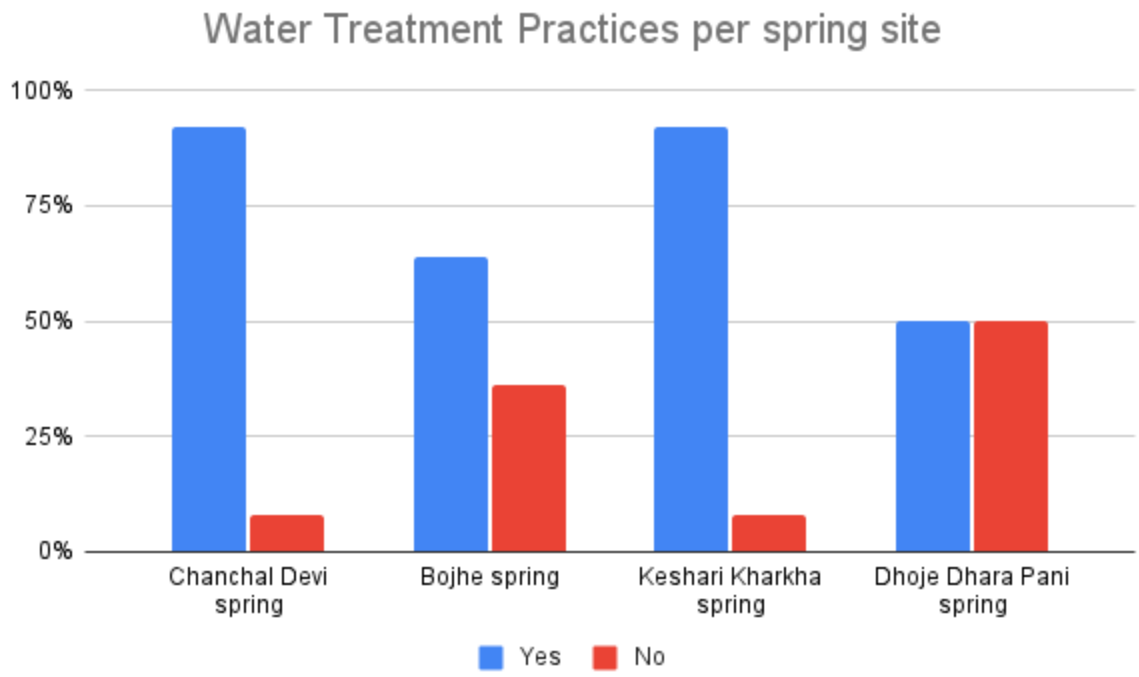


Figure 21: Water treatment practice per spring site.

The participants cited that the water from the spring sources is not directly used for drinking purposes, they usually filter or boil the water before drinking. The user HHs from Chanchala Devi spring site, Dhoje Dhara pani and Keshari kharkha spring site has been collecting water using a pipe connection from the spring source while the user HHs from Bojhe spring has been collecting water using a pipe connection from a collection tank.

4.4 Dependability and reliability of spring water

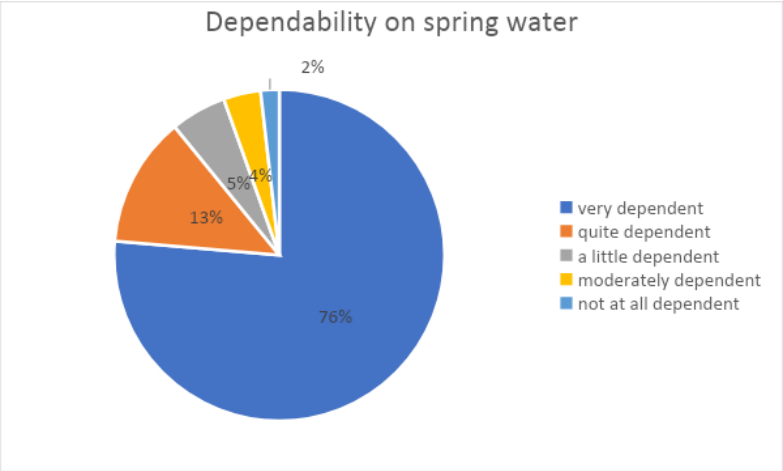


Figure 22: Dependability of surveyed HH on selected spring source.

The above chart shows that the overall surveyed households are hugely dependent on the springs for water, 76% indicates that they are very dependent on the spring source. The households (HH) falling under the categories of quite dependent (13%), a little dependent (5%), and moderately dependent (4%) are those that obtain water from other spring sources to fulfill their total water needs. In contrast, households categorized as not at all dependent represent those who were beneficiaries in the past but currently do not use spring water. This is mainly due to insufficient water in their previous spring source and an increase in the number of users over time. Table 5 shows the dependability perception for each of the 4 springs surveyed.

Table 5: Dependability per spring source.

Dependability	Chanchala Devi spring	Bojhe spring	Keshari Kharka spring	Dhoje Dhara Pani spring
Very dependent	25 %	86%	62%	100%
Quite dependent	25 %	-	38%	-
A little dependent	25 %	7%	-	-
Moderately dependent	17%	-	-	-
Not at all dependent	8%	7%	-	-

The perspective of user HH on the reliability of spring as a water source for drinking purposes is presented in Figure 23. The majority of the respondents perceived that the water from the spring is usually reliable (49%), and 47% perceived the spring source is always reliable as a water source. While 4% of the respondents perceived that the spring source was rarely reliable due to various factors such as insufficient water in the spring source, seasonal fluctuation in water quantity and increase in the number of users HH near the spring source.

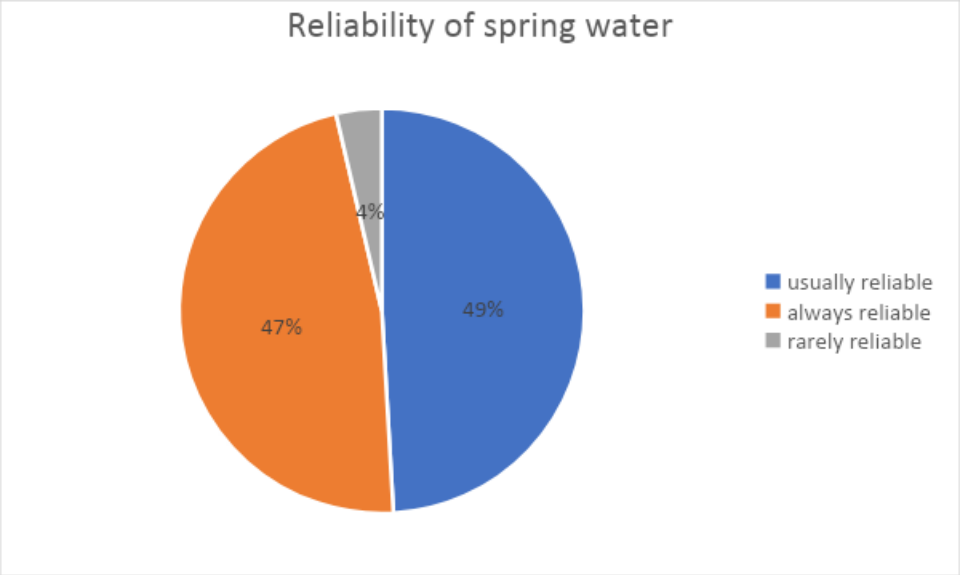


Figure 23: Reliability of spring water.

Further, the survey reveals a decrease in the number of spring-dependent households in both Chanchala Devi and Bojhe spring sites (Table 6). Respondents attribute this decline to the decreasing discharge in spring water, posing challenges in meeting the water needs of all households, leading some to shift to other water sources.

Contrastingly, in the case of Dhoje Dhara Pani and Keshari Kharka spring sites, the number of spring-dependent households has increased. This increase is associated with infrastructure development in the village, including the construction of roads and the provision of various facilities and services such as health, education, and markets. As people move closer to these facilities, the number of households dependent on these spring sources has increased.

Table 6: Change in spring water dependency over past 10 years.

Springs source	Municipality	Past HH Dependence	Present HH Dependence
Chanchala Devi Spring	DM	12-15 HH	10 HH
Bojhe Spring	DM	15-16 HH	14 HH
Keshari Kharka Spring	CJRM	5-6 HH	13 HH
Dhoje Dhara Pani Spring	CJRM	10-12 HH	16 HH

Discussion:

This chapter has discussed key aspects of the spring source usage, quantity and quality and perceptions around the dependence and reliability. A few things come out clearly, the people in all these locations are highly dependent on spring water for all types of water usage, drinking, domestic, livestock and irrigation, while spring discharge is generally decreasing with 25-50%. This does not directly seem to affect reliability,

as this is deemed always or usually reliable in a 50/50 division. But, it does come out that there are changes in the number of spring users who indicates that the water is not sufficient to meet the demand, this makes that some users now to go a spring further away. In addition, two of the springs had more users in the past who switched to other water sources as water quantity decreased. Right now, the management of water is majorly informal and is based on mutual understanding between 'neighbors'. However, when a specific structure is in place, such as a collection tank, this is likely to change as it requires more management for water distribution and maintenance. Water quality is generally perceived as having improved, whereas most people do use treatment for drinking purposes.

From this a 'hesitant' point can be made that decreasing spring water sources has only just started, and with the ongoing infrastructure developments, land-use change and climate change, this is likely to exacerbate. While people now can manage with their coping mechanisms of shifting to alternative sources, it is questionable till when this can happen and/or to what extent.

5. Additional water sources

The surveyed respondents reported that the quantity of water in the selected springs has decreased over the years by 25-50% and it is not possible to fulfill the water demands of all the dependent households at the present situation. 31% of the overall surveyed respondents are using other water sources due to the decreasing discharge in the selected spring, which is compounded by the increasing number of spring users, making the source more unreliable. The table below represents the additional water sources used in Chanchala Devi and keshari Kharka spring site:

Table 7: Additional water source of Chanchala Devi spring site.

Water source	Water Availability	purpose	Change in past 10 years
Padhera spring	Permanent	Drinking, Domestic, Livestock, Agriculture	Decreasing
Ghurmis Dhara spring	Permanent	Drinking, Livestock	Decreasing
Baldhangray spring	Permanent	Domestic Use, Drinking, Livestock	No change
Khop spring	Seasonal	Drinking, Livestock	Decreasing
Chanchala Devi waterfall	Seasonal	Livestock, agriculture	Decreasing
Padhere river	Seasonal	Livestock, agriculture	Decreasing

Most households in the Chanchala Devi (7 HH) and Keshari Kharka (4 HH) spring sites have changed their water sources. Among the 7 HHs in Okmalung village (Chanchala Devi) who depend on multiple water sources, 2 HH were past beneficiaries of spring water. They shifted to another source due two reasons i. increase in the number of users near this spring that resulted in insufficient water supply and compelled them to switch to another source and ii. the greater distance from the spring. The remaining households in the village are also accessing water from alternative sources in the area apart from the primary spring, i.e., Chanchala Devi spring.

Table 8: Additional water source of Keshari Kharka spring site.

Water source	Water Availability	Purpose	Change in past 10 years
Majhghare sim spring	Permanent	Drinking, Domestic	Decreasing
Jaymire botae spring	Permanent	Drinking, Domestic	Decreasing
Gurung gau siran spring	Permanent	Domestic Use, Drinking	No change
Tap water		Drinking, Livestock	No change

In Keshari Kharka spring area, some households had shifted to another spring due to i. easy accessibility and ii. more water availability in the new source or having tap water at home. While 2 HHs had moved to Keshari Kharka spring due to insufficient water in their previous source.

The majority of the households reported that the water demand of the household, after obtaining from all different permanent water sources, usually met while the water demand from the seasonal source is occasionally met indicating the water-related challenges to these households.

6. Agriculture, Land-use and Climate Change

Agriculture is the main occupation of people residing in our surveyed areas. 95% of the surveyed respondents are engaged in agriculture and the average land holding size is 10 ropani (0.51 ha.). The commonly cultivated crops in the farm, in different season over the years, are presented in table 9 below:

Table 9: Crops cultivated in different season.

Season	**Commonly cultivated crops**
Winter	Millet, potato, mustard green, oats, wheat, cabbage, pea, oat
Summer	Cabbage, cauliflower, pumpkin, maize, mustard green,
Monsoon	Chayote Squash, pumpkin, coriander, radish, cabbage, millet, Bitter Gourd, Green Bean, cucumber

In the past, farmers used to grow millet, maize and certain types of green leafy vegetables (for consumption only) as a major crop which has drastically changed at present to commercial agriculture i.e. cultivate various cash crops to fulfill the present requirements such as school fees, daily house supplies (rice, oil, salts) and various other things. Typical cash crops cultivated in the survey areas include radish, potato, pea, cabbage, cauliflower etc.

The respondents reported that the main reason for a shift to cash crops are:

- For millet and maize there was no market or limited market.
- Maize and millet take about 6 months to mature, while many vegetable crops are ready for harvest in about 3 months.

It was revealed that the area of agricultural land in the surveyed area has largely increased, especially in Dhoje Dharapani and Keshari kharkha spring area over the past 10 years. It is due to grazing land turned to agricultural land. The primary reasons being.

i. favorable climate established due to increasing temperature (no other crops used to grow due to chilling temperature in the past) and
ii. Introduction of road.

In the case of Chanchala devi and Bojhe spring area the agricultural land has decreased as community people started growing trees (Utis tree) in agriculture land where they used to grow millet and maize in the past. This is attributed to the following.

- Infestation of monkey into the agriculture area
- Outmigration: Household who has moved to city or out of Dhankuta started growing trees which requires limited engagement for monitoring too.
- Temporary migration of youth to abroad for work and study resulting to limited number of human resources (especially old people, and women) for agriculture.

6.1 Challenges with water for agricultural purposes

Usually, the water from the spring is not sufficient to fulfill the agricultural water demand leading to various challenges in water management for irrigating the field crops. Figure 24 represents the challenges faced by the respondents on water management in their farm. The most prevailing challenge in the farm is identified as a period of too little water/water stress (36%). Respondents shared that during the dry season the discharge from the springs and rivers decreases resulting to difficulty for the farmers to manage water in the farm. During the wet season, influenced by heavy rainfall and inadequate drainage systems, excess water from the spring sources and road runoff enters the field and causes damage to the standing crops in the field.

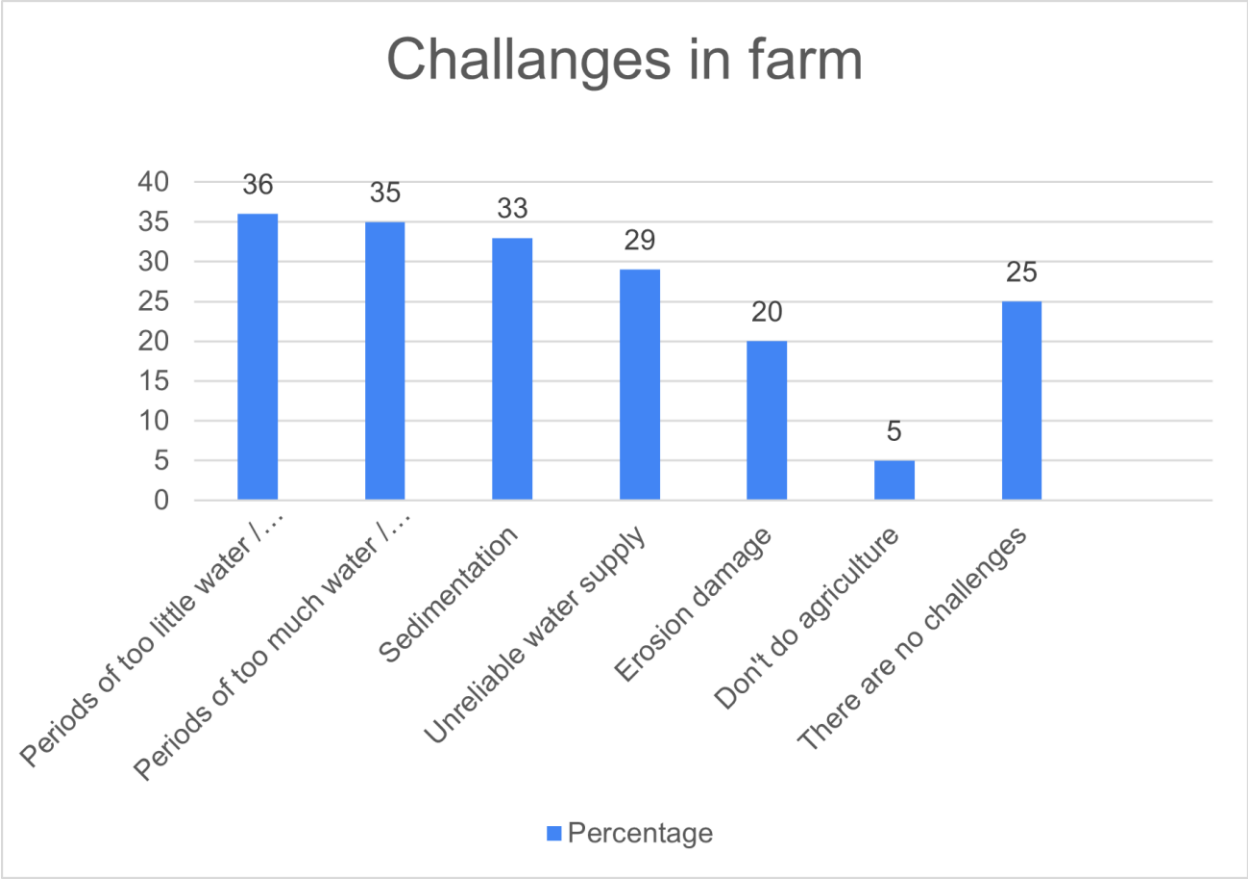


Figure 24: Challenge in farm water management.

In Bojhe spring site, community members do not use spring water for agricultural purposes; instead, they rely on rain or greywater for irrigation. On the other hand, in Keshari Kharkha spring site, farmers utilize water from nearby ponds to irrigate nurseries and certain land areas. In Chanchala Devi spring site, the majority of respondents have unlined ponds near their homes for storing water to irrigate fields. The community boasts 8-10 ponds, all recharged by river water. In Dhoje Dhara Pani spring site, plastic ponds with a 10,000-liter capacity store water for agricultural use, specifically for irrigating nurseries and some land areas. These plastic ponds are recharged through excess spring water. In all 4 selected spring locations they have given the main priority of spring water for drinking purpose over its usage for domestic, livestock and agricultural use.

A significant number of respondents highlighted challenges in agriculture due to sedimentation and erosion. The unmanaged drainage system on the roads helps to bring sediments together with water during the rainy season, of which, there is always a chance of these sediments entering the farm fields, posing problems for crops and farmers settlement area. Moreover, the deteriorating condition of spring water led to unreliability of water supply for irrigation.

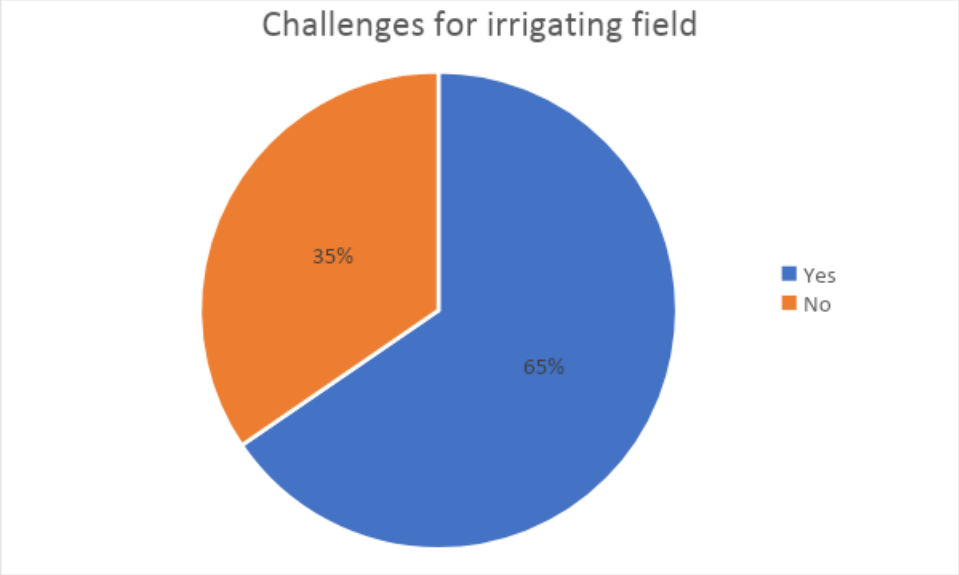


Figure 25: Challenges in irrigating fields.

Figure 26 indicates the instances of challenges for irrigation in the agricultural fields. 65% of respondents reported experiencing periods with too little water, which have potentially affected crop yields, then livelihoods. The respondents reported that the water demand for agricultural use is highest for months from January to May and the water from the spring is only sufficient to irrigate nurseries and a few areas of karesha bari.

Due to insufficient water for agricultural use the farmers were compelled to leave their crop fields to dry out resulting in lower yield. In the Bojhe spring area, farmers have to depend on the rainwater for their agricultural fields, and the grey water from the household is diverted into the field for irrigation purposes. On the other hand, in Keshari Kharkha spring area, farmers utilize water from nearby ponds to irrigate nurseries and certain land areas. Overflow water from the spring source and from the roof of the nearby CJRM office is harvested to capture this overflow water in the pond.

In Chanchala Devi spring area, the majority of respondents have unlined ponds to store water for irrigation purpose near the homestead area. The community boasts 8-10 ponds, all filled/recharged by river water. When they have excess water from spring, they use it to fill these ponds too. In Dhoje Dhara Pani spring site, plastic ponds with a 10,000-liter capacity store water for agricultural use, specifically for nurseries and some land around. These plastic ponds are filled by using the excess water from the spring after it meets drinking and domestic water needs. In all the surveyed spring sites, priority is given mainly for drinking followed by domestic, livestock and agriculture use.

While in the past, spring water was used for irrigation, the increasing number of spring-dependent households and decreasing spring discharge have made water management for irrigation challenging. While a notable percentage (35%) reported that they have not experienced any challenges managing water for agricultural irrigation as they manage water for irrigation from nearby rivers. They further use modern and more efficient irrigation technologies like sprinklers.

Figure 26: Farmers using sprinklers for irrigation in Bojhe spring site.

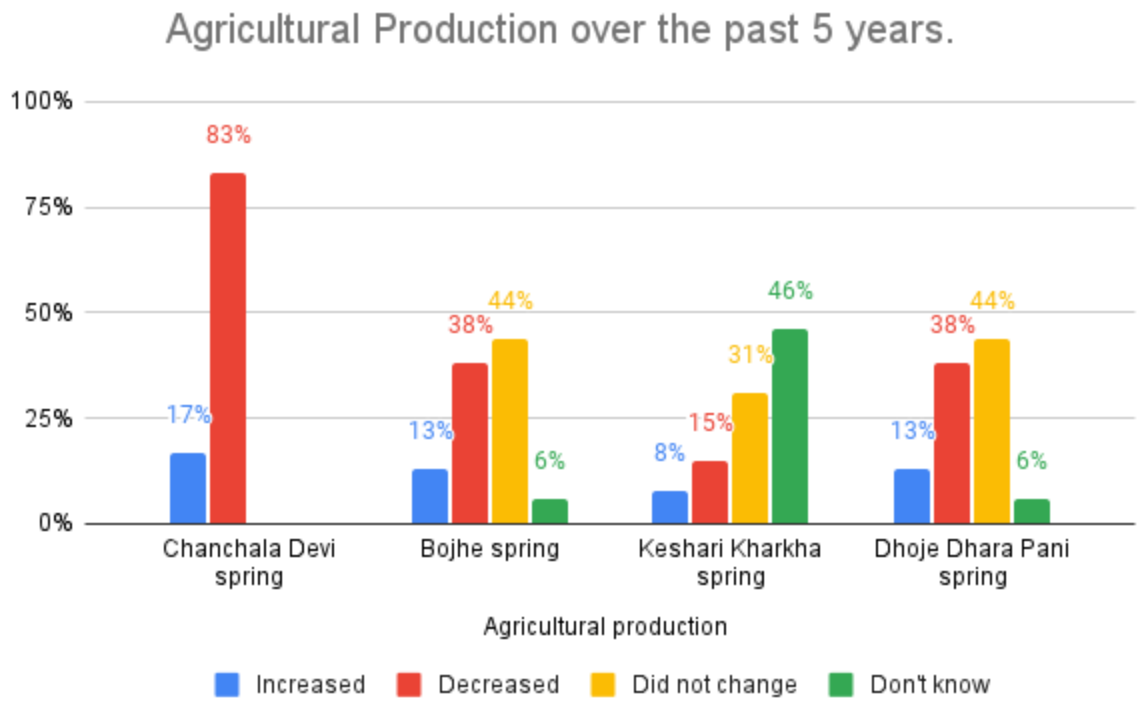


Figure 27: Change in agricultural production per spring site over the last 5 years.

Figure 27 shows the change in agriculture production over the past 5 years. Farmers from the Dojhe spring site have adopted modern/better techniques for cultivating crops. In the past, they used to spread crops like maize and pea randomly across the field, leading to higher cultivation cost. At present, they plant crops in ridges in a more organized manner, reducing cultivation expenses. Additionally, farmers have embraced techniques like cultivating in plastic tunnels, sprinklers for irrigation and mulching for growing crops and vegetables. The application of these techniques has helped to increase agricultural production. Farmers specifically have employed mulching techniques to address water scarcity for agriculture and to increase water efficiency.

Similarly, farmers from the Keshari Kharka spring site have taken proactive steps to enhance agricultural practices. They had conducted soil tests in collaboration with the district agriculture office. Following the soil test results, farmers began cultivating a variety of crops, including cabbage, cauliflower, radish, and cardamom, that are well-suited to their soil type. This strategic approach has resulted in an increase in agricultural production.

To summarize it: The respondents reported that the agricultural production has decreased due to various factors such as

- Insufficient water for irrigation purposes,
- Climate changes (mainly rise in temperature and irregular rainfall pattern),
- Disease in roots of crop resulting to rot of the roots,
- Insects' attacks on the crops such as white grubs and red ants and
- Invasion of monkeys in the agricultural field.

Whereas an increase in the production is due to various reasons such as

- Use of hybrid variety of crops,
- Soil quality test,
- Practicing modern farming methods such as plastic tunnels, sprinklers, mulching etc.

6.2 Impact of road runoff on agricultural production

The absence of a proper drainage system in the village roads has led to various adverse effects on both fields and houses. Respondents from Bojhe and Keshari Kharka spring sites revealed that road water runoff enters the fields, causing damage to growing crops and vegetables. Additionally, during travel, mud from the road enters their houses, either carried by pedestrians or by vehicles they drive. This has negatively impacted sanitation. Moreover, the movement of vehicles on the roads causes muddy water collected in depressions to splash onto nearby houses, making the surroundings unappealing. In response to these impacts the respondents highlighted some of the common solutions for the road water management such as providing proper drainage, causeways or paving the roads, construction of gabion wall in the roadside to prevent erosion and retain the slope.

6.3 Changes in land-use

The surveyed participants highlighted a notable and dynamic transformation in the community's landscape, housing, and infrastructure over the past years. The shift is characterized by significant changes influenced by the growing population of villages. One evident change is the expansion of settlement areas, reflecting the community's response to the increasing number of residents.

Furthermore, the alteration in land-use is evident in the conversion of grazing lands into resorts, marking a shift from traditional land utilization to more commercial and recreational purposes. This change not only reflects economic developments but also indicates a shift in the community's priorities and utilization of available resources.

Table 10: Land-use distribution across the 4 selected spring sites.

Estimated area (%) → Land-use ↓	**Chanchala Devi**	**Bojhe**	**Keshari Kharka**	**Dhoje Dhara Pani**
Agriculture	60	70	75	65
Forest	20	25	20	30
Settlement area	20	5	5	5

In Chanchala Devi and Bojhe spring sites, respondents note a significant change in the land-use pattern over the last 10 years. The majority of agricultural land has transformed into forest areas while the grazing land is now replaced by the resorts and settlement areas. This shift is attributed to challenges faced by farmers, including monkey infestations on field crops and the migration of youth to urban areas or abroad for employment.

The community emphasizes that the conversion of agricultural and grazing land into forests has impacted their income. The predominant tree species in the forests is Alnus nepalensis (locally named Utish), which takes 10-15 years to mature for selling purposes, providing a delayed return compared to the quicker returns from vegetable cultivation. However, with a lack of youth in households, older parents are left to plant trees in agricultural areas, resulting in a decline in agricultural production. This shift poses challenges to the traditional farming practices and economic sustainability of the community.

Contrastingly, community members from Keshari Kharka and Dhoje Dhara Pani Springs site have experienced a different transformation. They report that there has been an increase in agriculture, forest and settlement area over the last 10 years. The grazing lands are converted into agricultural lands for commercial agriculture. According to the community members in Dhoje Dhara Pani spring site, there has been a substantial (95%) increase in the number of people engaging in commercial agriculture as a major source of income.

Typically, farmers in these areas practice intensive farming, involving significant capital investments in seeds, tractors, fertilizers, pesticides, and other advanced techniques. While these investments can yield profits from the sale of vegetables, the farmers also face the risk of incurring losses, particularly when market demand fluctuates. This shift towards commercial agriculture signifies a changing economic landscape for the communities, highlighting the challenges and opportunities associated with modern farming practices.

The grazing lands in all four selected spring locations have been entirely converted into forests, settlement areas, or repurposed for agriculture. This change has compelled livestock to be confined within sheds, impacting traditional grazing practices.

6.4 Climate change impact

There is a drastic change in the climate of the Dhankuta district. Over the last decade, there has been a noticeable rise in temperature, irregularities in rainfall patterns, and changes in rainfall intensity. These climate shifts have directly impacted various aspects of the community, particularly agricultural production, livelihoods, and the spring sources in the area.

In Chanchala Devi spring site, respondents noted drastic changes in climate, with an increase in temperature and alterations in the pattern and intensity of rainfall. Previously experienced extreme cold and frost in early October-November months, the region now rarely witnesses frost, even in the coldest months. Changes in the rainfall pattern, with shorter but more intense rain, have affected agricultural cycles, especially the timing of crucial rains needed for crop growth.

In the year 2004/2005 AD, the community members from Bojhe spring site faced a severe drought issue characterized by late rainfall and rising temperatures, rendering the conditions unsuitable for maize cultivation, resulting in crop failure. In the present time, a similar scenario persists with delayed rainfall contributing to a reduced flow in the springs. The rapid increase in temperature further exacerbates the situation, causing the sources to dry out through the soil surface. This consistent pattern of late rainfall and elevated temperatures poses ongoing challenges for agricultural activities and water availability in the area.

In Dhoje Dhara Pani spring site, the past decade brought major climatic changes, including reduced snowfall, irregular rainfall, and higher temperatures. This has led to drying up of spring water sources, with rainwater from upstream roads introducing pollutants. Community members are actively taking measures like providing small drainage in roads, or small walls above the spring to mitigate the impact of rainwater from upstream roads.

Figure 28: Small wall constructed adjoining to the spring to prevent it from the sediment carrying runoff in Bojhe.

Keshari Kharka spring site also witnessed drastic climatic changes, with increased temperatures, irregular rainfall, and changes in rainfall intensity. The rise in water levels in nearby ponds during monsoon has led to gully formation. Unlike other spring sites, the community reported not to have taken any adaptive measures to cope with these climate impacts.

Figure 29: Gully formation down the road due to water from Keshari Kharka spring.

6.5 Local Knowledge and Biodiversity

In the surveyed area in Chanchala Devi spring site, different species of plants like Utish (Alnus Nepalensis), Amriso (Thysanolaena maxima), Paulownia, Dalae ghas, gobre sallo (Pinus wallichiana) are easily available. Utish is the predominant tree species grown for commercial purposes due to its high value and are material for plywood, boxes for packaging, and in some light construction work. Amriso (Thysanolaena maxima) is another species abundantly found in Dhankuta. It is used to make brooms. Paulownia species is also available in the area, but the local community expressed that is not beneficial to them as they have no idea or are unaware about its uses and advantages. Dalae ghas is a plant species used as livestock fodder. As per the local resident's, tree species like Alnus Nepalensis (utish), Pinus wallichiana (gobre sallo) bamboo, and Cinnamomum tamala (masala tree) are responsible for the drying up of the spring water sources.

The forest area in the upstream site of Bojhe spring, mainly have utish (Alnus Nepalensis) tree species, is governed and managed by the Drinking water office in Dhankuta. This area has numerous water points/springs that are being tapped and distributed mainly in Hile area.

As per the experience of the residents they mentioned that most of the ponds, especially on the top of hill sides, have dried out due to the increasing rate of forest area in the community, Members of the community share that they think the big trees absorb more water from the surrounding area and are the reason for the drying of ponds. The forests in the spring site area are both public as well as private forests. The public forests are governed by the users committee and are allowed to use/harvest timber from the forest while outsiders are not. Even the committee members must obtain authorization from the forest department before chopping down any trees in the communal forest.

There is only private forest in the Keshari kharka site area with tree species of mainly Alnus Nepalensis "Utish" and dalae ghas. As per the community people they experience that Alnus Nepalensis trees are bad for water restoration as it absorbs more water from the ground and dries it out, whereas Urtica dioica (sisnu), Brugmansia (dhokre phool), banana trees are good for water restoration.

In the Dojhe Dhara pani spring site major available plants are Alnus Nepalensis (Utish), Pinus wallichiana (gobre salla), Rhododendron arboreum (laliguras), Zanthoxylum planispinum (timur), Eucalyptus globulus (Masala), Ficus roxburghii (nebara), Meliosma dilleniifolia (gogun) and dalae gash. Alnus Nepalensis was mainly found in both the private and public forest land area as they could be sold at high prices. There are communal forests in Dhoje Dharapani area. These communal forests are managed by the users' committee. The committee operates/organizes monthly meetings for the management of forest products/resources. The committee organizes an afforestation programme in the bare communal land area. Every member of the users' committee needs to participate in the meetings, and activities related to protection and management of the communal forest. In their absence from any meetings, the members are charged NPR 500-700 per person.

6.6 Water harvesting and soil conservation practices

Community members from Chanchala devi spring site are planting a variety of trees, including Paulownia, Amriso, and Utish, to control soil erosion and/or for soil conservation.

In the Bojhe spring site, for soil conservation they have not practiced any method or have a soil test in the field. But the community people were given a 16-day training on preparing insecticides using locally available resources as neem, pompha and other various material by Agricultural Knowledge Center, the result of the use of prepared insecticide had no effect on the field insects, mainly khumlay (white grubs) and red ants.

While the farmers from Keshari Kharka spring site have tested their soil in a lab with the help of the district agriculture office at dhankuta and adopted the crop suggested for that particular areas. This helped to increase agricultural production according to farmers. After the soil testing farmers have started cultivating the crops that are suitable for their soil. Community people have not harvested water from the road over the years as the water is of no use for them and diverted to the river.

Similarly, the farmers from Dhoje Dhara pani spring have tested the pH level of the soil two times to understand the nature of the soil and have applied potassium (potash) in the field as per the recommendation. Also, they use compost manure from livestock as a fertilizer to increase productivity in the field.

Discussion

This chapter explained the fundamental aspects of agriculture, land-use and climate change and impression of it on the springs and water. It is clear that agriculture practices in the area have changed drastically compared to the past. Farmers have shifted to commercial agriculture (cash crop) to adjust with the change in the surrounding context for instance road development helped in the easy access to market and market demand. On the other side, there is a challenge to manage water for agriculture because of too little water in dry periods that affects crop yield and too much water during rainy season affecting the standing crops due to rain, springs and road runoff entering the farmland. The effects/events of too little water in dry spell and too much water in rainy season is exacerbated by the climate change (increased temperature, irregular rain events and reduce in snowfall in CJRM) and land use changes (grass land/pasture area turned to agriculture area in CJRM, agriculture land turned to forest land especially covered by Utish in DM, expansion of settlement areas, development or road without proper drainage system affecting agriculture by entrance of road runoff along with sediments to agriculture land etc). Springs are not an exception from the effect of climate change and land use changes. Further, the growing dependency on spring due to the increased number of users has increased challenges on the availability of water from springs to the agriculture sector as drinking and domestic use of water gets priority over it.

To cope with this, local communities started opting for coping strategies like construction of ponds to store water for agriculture use, mulching to conserve water, adopting efficient irrigation techniques like sprinklers.

Though, the communities see abundant of water from the road and its effect in their settlement and agriculture land, they have never thought of or had an idea of conserving and using it. They have shown huge interest in the use of such opportunities.

7. Transport, Mobility and Road Network

The majority of the roads in the selected spring sites are feeder roads with gravel and sand surface while the road joining the Bojhe spring is rubble soling. These roads are mainly constructed through the user committee and village development committee and are also the responsible bodies for their repair and maintenance. The road serves as the village's conduit for the development of infrastructure and accessibility to numerous amenities and services like health, education, market and employment opportunities.

The road has also served as a medium for the farmers in the village to transport their grown products to the market. The people perceive the quality of the roads in the village to be of average condition that help to connect the village with the various facilities and services. Most of the roads in the village do not have the provision of a drainage system, which causes multiple issues causing road downtime. Therefore, most of the roads are inaccessible during the monsoon season (July-September). Lack of drainage and average to heavy rainfall in the area causes water logging on roads, especially in the depressions. This makes travel more difficult and time consuming, especially for the movement of heavy loading trucks and tractors.

These issues highlight the potential concerns for water management during adverse weather conditions. The roads in the village are usually accessible throughout the year for light vehicles like auto-tempo and motorbikes, while cars, trucks and tractors often get stuck in the road sections that are in a depression and often are troubled by waterlogging. The repair and maintenance of these roads in the selected spring site are often carried out during monsoon or only when the road becomes inaccessible for the people in the village.

Figure 30: Adjacent Road in Chanchala Devi spring site

Figure 31: Adjacent Road with rubble soling in Bojhe spring site

Figure 32: Adjacent Road impacted by spring water in Keshari Kharka spring site

Figure 33: Adjacent Road in Dhoje Dhara Pani spring site

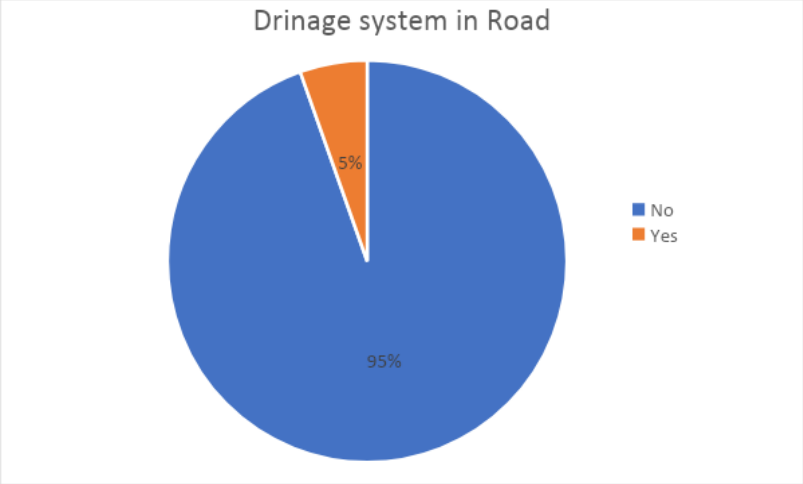


Figure 34: Drainage system in road.

A majority of the respondents reported that the selected spring source has an impact on the adjoining road infrastructure. The chart below shows the most common impacts, from highest to lowest impact these include: waterlogging/flooding, damage to the road surface, erosion, sedimentation, and damage to the road embankment. These challenges highlight the vulnerability of the road to water-related issues, emphasizing the need for improved water management along the roads.

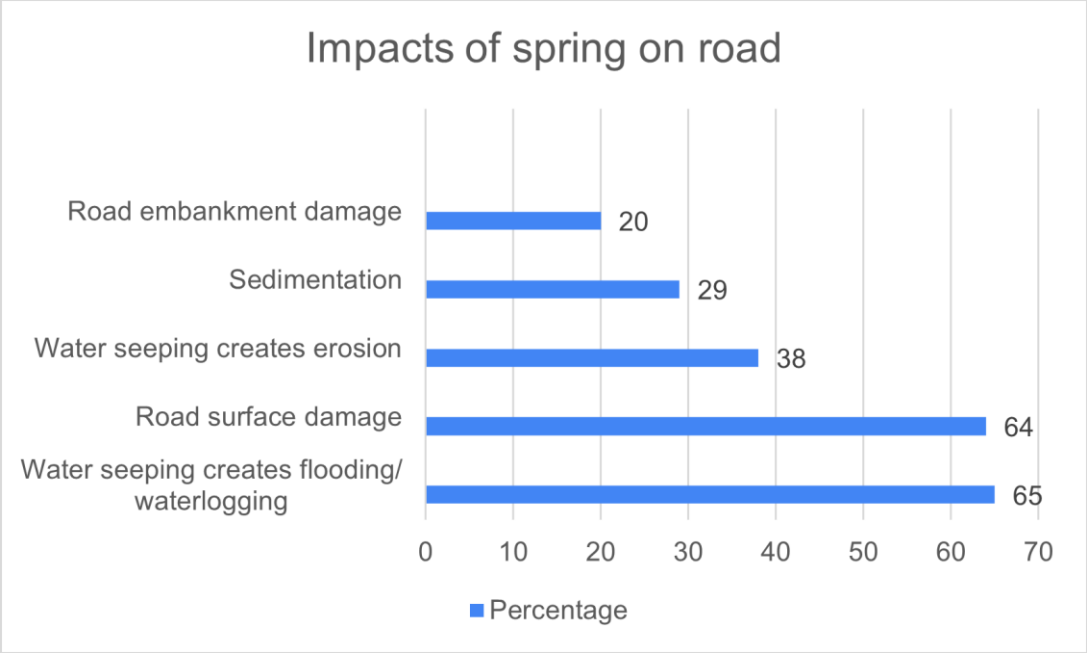


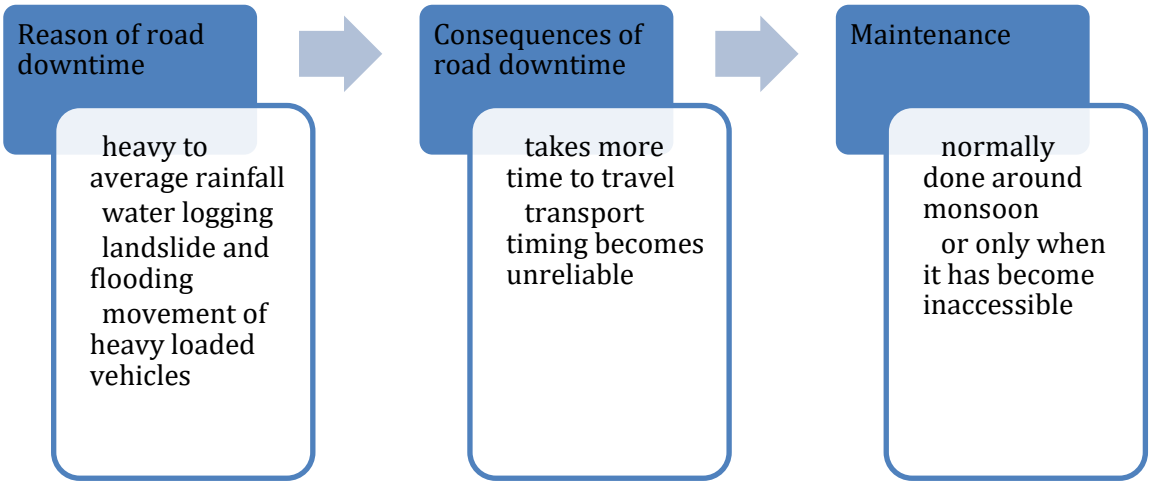
Figure 35: Impact of spring water on road.

Figure 36: Road surface damage and gully formation at downstream side of keshari Kharka spring

7.1 Road accessibility

The main impacts to the road caused by amongst others spring seepage water, are road surface damage, water seeping which creates erosion, road embankment damage, waterlogging and sedimentation. This leads not only to a negative impact to the road and its surroundings and agricultural fields, but it also means costs for maintenance and repairs of roads and adjacent lands and infrastructure. And furthermore, it means disturbance to the people who make use of the road to for instance market their produce or go to school.

Many roads are either not, or limitedly accessible during the monsoon months from June-September.



Discussion:

It becomes clear that road infrastructure in the four spring sites is of great importance for providing access to amenities like healthcare, education, markets, and employment opportunities. Roads serve as conduits for development. But the perception of road quality can be called average to poor. People especially are hindered by the lack of drainage on most roads causing major issues during the monsoon season. The major impact for people is in roads becoming inaccessible and extended/unreliable travel time. Common impacts include waterlogging/flooding, damage to road surfaces, erosion, sedimentation, and damage to road embankments. These challenges underscore the vulnerability of roads to water-related issues, necessitating improved water management practices along roadways.

As these roads are constructed and maintained by user committees and village development committees, it presents a case of addressing water-related challenges to maintain road functionality and safety in a cost-effective manner, especially given the adverse impact of spring seepage.

8. Socio-cultural aspects and governance

89% of overall respondents are engaged in various community activities and programs such as afforestation, road construction, social services (water supply, education, health), soil and water conservation amongst others. This active participation showcases a robust sense of community involvement that values collaboration and collective actions. The most common nature of participation is on topics relating to spring water sources, roads and various development programs through a formal community organization (84%). Similarly, the respondent indicates a diverse channel for involvement through the informal community organization (82%) as well as through the political leaders.

Community members commonly gather informally when addressing conflicts or engaging in religious activities within the community.In contrast, discussions concerning water, roads, and other development initiatives follow a formal channel through user committees. These committees operate under specific rules and regulations established by the community members themselves, providing a structured and organized platform for addressing key community matters. This reflects a balanced engagement approach, with the community members leveraging both the structural and more flexible platform for collaboration.

Community members have been contributing to various initiatives in the village by showcasing a combination of physical efforts, financial support and material contribution. This comprehensive approach to community engagement enhances the overall impact and sustainability of community development activities.

8.1 Ownership and management of water sources by communities

Chanchala Devi, Kheshari Kharka and Dhoje Dhara pani spring lack a formal water management system or a user committee. Due to which it usually takes more time to address any issues around the spring source or distribution system. Residents are freely using water without any restrictions, accessing it directly through pipe connections from the spring. Community members informally gather for maintenance and management of the spring source and surrounding area. As the community people have not formed any user committee for water source so there are no customary rules for the management of spring source. A conflict can arise when someone connects a pipe while someone else is still using it, but this is normally resolved between the two users based on mutual understanding and appropriate behavior.

Example from Chanchala Devi:
In Chanchala Devi everyone in the village is permitted to use water from the source. Every household in the village is dependent on the spring sources for different purposes. Currently not every household is able to receive equal amounts of water from the spring due to insufficient water and larger distance between houses and spring such that downstream households only get very little amount of water. If the household in upstream refuses to provide water from the upstream spring source, they will likewise not receive water from the source in the upstream side of the household during a period of water scarcity, as they typically have been giving priority to the person who is most impacted.

In Chanchala Devi the water distribution system is essentially top to bottom. The main pipes are installed in the spring source, and numerous branches carry water from the main pipes to each individual house. Once they have sufficient water, the main pipes are connected into downstream pipes to allow the water to flow downstream. Community members get together, talk about problems, and come up with a common solution whenever there is a dispute over water. For instance, when the downstream household doesn't get sufficient water from the spring and the upstream household doesn't coordinate for water distribution during scarcity conditions in such cases minor disputes arise and community members gather to discuss and come up with a common solution. One of the participants during the FGD mentioned that if any individual in upstream would refuse to provide water, then that household will also not get water from another upstream household during the condition of scarcity.

In the agricultural field, men are primarily involved in water management, and women typically fetch water for the household. However, men also assist with fetching water where needed. Since each home has a direct connection to the source through the water pipes. However, it takes thirty minutes for two houses to get water from the source during the water scarce period, from Dhurmis Dhara spring.

There are currently no water development plans from NGOs or the government. Not all agricultural needs can be met by the water from Chanchala Devi spring sources; rainfall and river water are managed and utilized for livestock and irrigation. Another program for irrigation is the Okmalung Irrigation system, which is governed by its User Committee and has specific guidelines. Water from the river is collected into the dam in the Okmalung irrigation system through a canal which is 100m long and farmers are allowed to take water from the dam to their agricultural field through pipes.

Bojhe spring management

While Bojhe spring site has a 10,000-liter collection tank to store water, which is then distributed to 12 households through pipes. The distribution is facilitated by opening the gate valve in the tank, with 10-11 gear valves downstream connecting the main pipe to distributary pipes for equal water distribution (refer to figure 13). The gate valve is opened twice a day, in the morning and evening, each time for approximately 30 minutes by the member of the nearest HH in a voluntary approach.

In case of pipe leakage or other issues, the community members address the problem through discussion within the user's committee (Tin Talae Sinjali user's committee). They inspect the gate valve for any faults and clean it if necessary to resume water distribution. To ensure the upkeep and management of the spring sources and collection tank, community members gather weekly for maintenance activities through the user committee.

8.2 Coping with water scarcity

To cope with the existing problem of water scarcity in the area, users of Dhoje Dhara Pani spring are conserving the existing water sources to meet the water needs of a growing population. Drums of capacity 300-500 liters are used to collect water in each house for drinking, domestic and livestock purposes. 3-4 small plastic ponds of 10000 liters capacity are constructed in the community for fulfilling the irrigation water needs out of which only 2 are now in use to collect water mainly from rainfall during monsoon and sometimes the excess water from road and roadside springs are diverted to these ponds. The water from

the ponds is only sufficient to irrigate small areas in the field, nurseries and karesha bari. Community people have been depending on rainfall for irrigating their whole agricultural field.

Other coping strategies practiced include:

- Informally managing the available water resources by opening the water pipe for a certain period only and closing after the water is enough.
- Coordinating with the neighbors for water during scarcity conditions.
- Coordinating and managing water from the spring sources that are in private agricultural land areas.

Other possible coping strategies that were suggested:

- Informal discussion with User Committee about deep boring regarding water scarcity in downstream Spring sources.
- Lifting of water from Nibuwa river.
- Seepage control and collecting in tanks after filtration and proper distribution to people.

8.3 Future perspective community

Migration is different in every community, in Chanchala Devi for instance the in-migration rate exceeds the out-migration rate, while in Bojhe, Keshari Kharka and Dhoje Dhara Pani, there are more people who out-migrate to various other places for work and higher education purposes, such as Dharan, Itahari, Kathmandu, India, Saudi Arabia, Qatar, Malaysia and Dubai. In Bojhe, there are 2-3 households that have already migrated due to shortage of water and work opportunities to other places.

Major changes have occurred in all the four localities over the past 10, 20 and 50 years, which are considered both positive and negative, these include:

- Land-use change: drastic decrease of grazing lands, livestock are limited to their sheds. Land-use has changed along with it, mainly towards agricultural production of cash-crops, settlement area and forest.
- Infrastructure development: after the introduction of roads in the village it has connected the village to the market and other various parts of nepal which have made health, education and services easily accessible to each individual of the village.
- Technological advancement: Over the years there was also a revolution in farming practices, farmers started practicing modern techniques of farming in the village. However, insect and monkey infestation, and water scarcity pose severe challenges to agricultural production.
- Climate change: especially higher temperatures, change of seasons, irregular and high intensity rainfall cause problems.
- Dwindling water sources: with higher water demand and reduced replenishment, water sources are depleting. The locals mention that in the next 10 years water shortage will be a serious problem which will impact the growing population of the village. It will be difficult to manage water for daily life of the residents as agriculture will not be possible without irrigation.

In all the villages the people indicate that there are positive and negative sides to the different developments over the years. And what they have in common is their appreciation of their village, their community, their geographical features and the good understanding between people with their indigenous language and culture. Something to be proud of!

9. Key informant interview results

Soil and Water Conservation:

In an interview with Watershed Management Officer Prakash Limbu, several key issues related to water, roads, and the watershed were identified. These include sedimentation in spring intakes, open intakes allowing contamination, and difficulties in accessing spring sites. Community concerns regarding construction distance from spring sources and conflicts between beneficiary communities were also highlighted. To address these issues, programs such as tunnel farming training, plastic pond construction, fruit tree distribution, and tourism-focused plantation initiatives are underway. However, challenges such as budget constraints, lack of technical manpower, and program prioritization persist.

Opportunities for improvement include collaboration with external partners, staff training, and active involvement in policy-making processes. Regarding springs, challenges include sedimentation, contamination, and accessibility issues. Mitigation efforts involve retaining wall construction and infrastructure improvements. Despite these challenges, the officer believes that current programs have effectively addressed spring-related issues, albeit with ongoing challenges in committee conflicts and site access. Looking ahead, opportunities lie in utilizing budget allocations more effectively and addressing ongoing project needs.

Road Division:

In an interview with the Division Chief of a road division, Ram Kumar Dev, various issues related to road construction and management were discussed. The Division Chief outlined several challenges, including disputes over road alignment through private lands, difficulties in relocating roads through settlements, and environmental impacts such as damage to wildlife and biodiversity in forested areas due to road construction. Additionally, monsoon floods and landslides were identified as factors damaging road surfaces.

To tackle these issues, the division has implemented skill development programs and annual workshops on road condition surveys. Despite these efforts, challenges persist in road alignment designs, natural disasters, and increased construction costs due to surface water sources. The Division Chief emphasized the need for emergency budget allocations to address damages caused by natural disasters. While acknowledging the effectiveness of current programs, challenges remain in program management procedures, limited budgets, and lack of technical manpower.

However, opportunities for improvement include exploring collaborations with other departments or external partners and investing in training and development programs for existing staff. The Division Chief highlighted positive changes brought about by road construction, such as reduced transportation costs, improved business activities, increased agricultural production, and better access to essential services like schools and healthcare.

Irrigation Division:

Pradeep Shrestha, Information Officer from the Water Resources and Irrigation Development Division, discussed water management issues in the area, specifically focusing on irrigation and springs. The officer identified several challenges, such as unequal water distribution among users in different

sections near water sources, political interference within user committees, open and unmanaged spring sources, and canal leaks. To address these issues, the Irrigation Division conducts training programs in phases, covering project overview, maintenance, and stakeholder roles. Additionally, political interference is managed through collaboration with ward offices, while intake construction and leakage repairs are carried out using committee funds.

The officer confirmed that these programs effectively address the identified issues. Tools and approaches used include simple presentations, the Medium Irrigation Project for canal surface irrigation, and Non-conventional Irrigation Technology Projects for sprinklers and lifting systems. Despite the effectiveness of these policies and programs, challenges remain due to topographical issues requiring additional structures, landslide-prone areas necessitating retaining structures, and new water sources appearing during construction.

Opportunities for improvement include involving local communities in construction work for income generation, increasing crop production, and utilizing modern irrigation tools in challenging landscapes. Positive changes observed in the working area include increased crop production and the transformation of dry areas into green, cultivable fields.

When thinking of "spring," the officer visualizes a water source suitable for irrigation. Challenges around springs include their open and unmanaged nature, topographical difficulties in reaching them, and their typically lower discharge compared to other water sources. To address these challenges, protective measures like small walls and chambers are built around spring sources, and gabion work is carried out in landslide-prone areas. Headwork structures are constructed downstream to collect and channel water into canals.

Looking forward, the officer sees opportunities in the irrigation process, focusing on tapping water from springs for irrigation while ensuring minimal impact on their natural state. Moreover, irrigation through earthen canals aids in groundwater recharge, benefiting both new and previously dried spring sources.

Drinking Water Division:

During the interview with the Sub-engineer from the Dhankuta Drinking Water Division, several key insights regarding water management and watershed issues in the area emerged. The primary issue identified pertains to the topography, with water sources often located in inaccessible areas such as forests or hills. This, coupled with moderate changes in project alignment due to climatic activities, poses challenges to accessibility and contamination risk.

Despite limited budget allocations, ongoing programs such as water supply construction and water quality testing demonstrate efforts to address these challenges. However, challenges persist, including coordination issues, lack of equipment and manpower, and delayed project completion.

Opportunities for improvement include gender-inclusive participation in user committees and community involvement in project activities, fostering skill development and employment opportunities. Notably, awareness of sanitation and the empowerment of women in the community have improved.

Additionally, regarding springs, challenges such as lack of management and decreasing discharge leading to migration were identified. Mitigation efforts involve infrastructure construction and community engagement, aligned with the organization's policies. Although challenges persist, opportunities exist in

spring conservation, gender equality initiatives, and sociological studies to inform policy and program development.

10. Conclusion

In summary, the baseline survey reveals key findings that provide valuable insights for the upcoming design phase and impact assessment. Here are the key conclusions:

- Springs are the main source of water for drinking and domestic use, livestock, and agriculture. Agriculture gets the share once other demands are met. In the meantime, these springs sources are in the process of drying making it hard for farmers to manage water for agriculture as the available water could barely meet other demands especially during dry spell. Communities are interested and trying hard for the sustainable use of those resources.

- The introduction of roads in DM and CJRM has brought numerous benefits to the communities, such as improved access to markets, educational facilities, health services, and employment opportunities. However, there are concerns within the community that road infrastructure contributes to the depletion and shifting of springs. Additionally, roads without proper drainage facilities have led to several problems, including waterlogging, flooding, road surface damage, erosion, sedimentation, and damaged road embankments. These issues cause difficulty in road usage and result in extended and unreliable travel times. The development and expansion of markets and settlements, along with road expansion, have increased competition for limited water resources. This has led to urban-rural and intra-rural water competition. The growth of urban areas and markets further elevates water demand, prompting the search for additional water sources. Moreover, the accumulation of households near roads increases pressure on available resources like water.

- The average reliance on spring water among surveyed respondents is approximately 50 years, primarily catering to daily household needs, agriculture, and livestock. However, challenges such as decreasing water quantity, shifting water sources, and insufficient availability pose concerns. Especially when the trends from the past 10 years are extrapolated into the future, this would present further depletion of water availability while demand is expected to go up. A serious challenge, since dependency on spring sources is high.

- All the selected spring sources are open, perennial and diffused types of spring source with higher dependability on spring. 31% of the surveyed respondents are reported using multiple water sources due to decreasing discharge in the selected spring, which is compounded by the increasing number of users near the spring source, making the source unreliable.

- The survey reveals significant changes in agricultural practices, land use, and climate across the surveyed spring sites. While there's a shift towards commercial farming and cash crop cultivation among respondents, challenges like water scarcity, climate fluctuations, and pest infestations hinder agricultural productivity. Despite these challenges, farmers are adopting modern techniques to enhance productivity, such as soil testing, mulching, and plastic tunnels.

- Additionally, changes in land use, driven by economic factors, and climate changes are affecting agricultural cycles and water availability with implications for livelihoods and community resilience. Effective adaptation measures, such as improved water management and drainage

systems are crucial to sustain agriculture in these communities and mitigate the impact of climate change.

- The majority of roads in selected spring sites lack a proper drainage system, resulting in accessibility issues during the monsoon season due to waterlogging and road surface damage. This poses challenges for heavy loading vehicles, such as trucks and tractors, causing downtime and hindering transportation. Repair and maintenance of roads are often carried out only during the monsoon or when the roads become inaccessible, underscoring the need for proactive measures to address water-related issues and improve road infrastructure resilience.

- Additionally, the selected spring sources have a significant impact on adjoining road infrastructure, primarily manifesting as waterlogging, road surface damage, erosion, sedimentation, and damage to road embankments. These findings underscore the importance of integrating water management strategies to mitigate the vulnerabilities of road networks to water-related challenges.

- Most of the respondents are actively participating in various programs and activities. Formal channels, like user committees, address key community issues such as water sources and road construction, while informal gatherings handle common household conflicts and religious matters. This balanced approach, supported by contributions of effort, finances, and materials, enhances the effectiveness and sustainability of community development initiatives.

These findings serve as a foundational understanding for the subsequent phases, guiding the design of interventions aimed at sustainable water management and infrastructure development. The active community engagement observed underscores the potential for collaborative efforts in addressing challenges and fostering positive change.

11. Recommendations

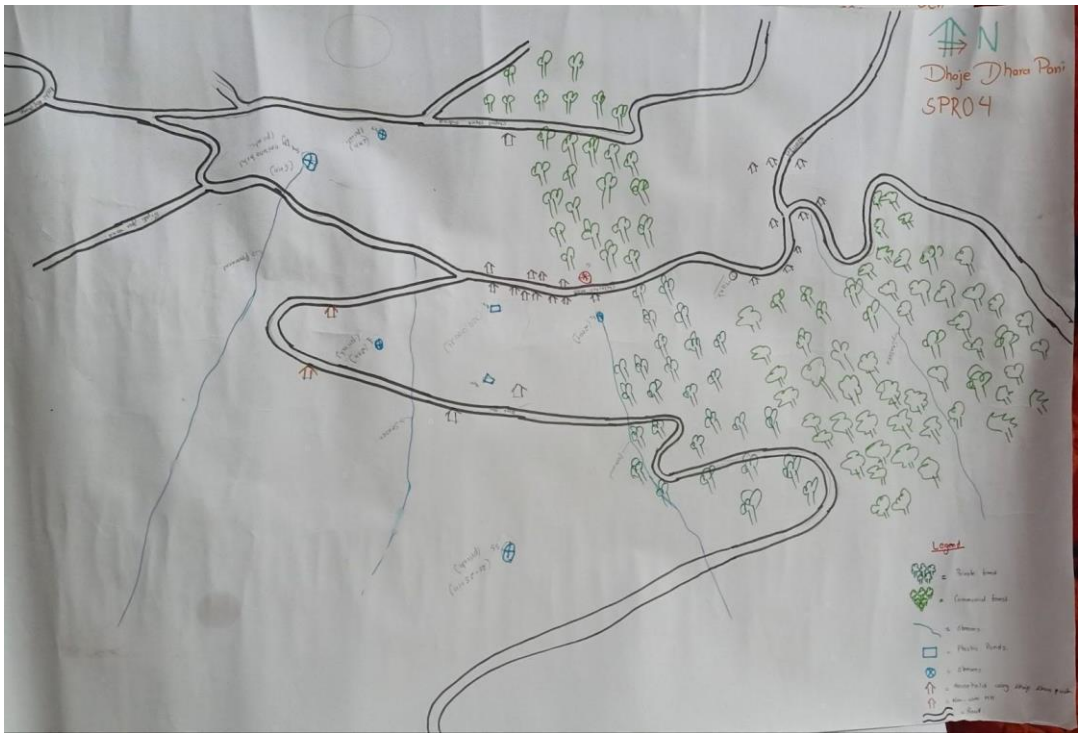
Based on the findings, the following recommendations are proposed to address the challenges in spring locations. These will be integrated into the next phases of the RoSPro project to enhance its effectiveness. These guidelines can also inform comprehensive and sustainable development strategies for other regions facing similar issues with water sources, infrastructure, and community livelihoods:

1. **Roadside Spring Management**: Integrate spring management into road development projects to minimize the impact on water sources.
2. **Utilizing Roads for Water**: Explore opportunities to use roads for efficient water management and distribution.
3. **Improving Water Storage Methods**: Promote efficient and reliable water storage practices. Offer guidance and support for maintaining and improving existing storage methods such as drums, gagris, and collection tanks. Conduct community workshops on proper storage techniques.
4. **Enhancing Water Quality Awareness**: Develop educational programs on water testing and treatment. Provide affordable and accessible water treatment options to ensure safe and clean water for consumption.
5. **Addressing Water-Related Road Issues**: Implement strategies to prevent waterlogging, control erosion, and repair surface damage. Engage with local authorities and communities to establish routine maintenance practices for the longevity of feeder roads.
6. **Encouraging Community Participation**: Leverage the strong community participation to establish community-led initiatives for water management and infrastructure development. Form water management committees and provide training to empower local communities to sustain the interventions.
7. **Collaborative Decision-Making**: Involve the community in the planning and implementation stages of interventions. Ensure that community perspectives, needs, and preferences are considered to reinforce a collective commitment to positive change.

Annex 1: Participatory Mapping during FGD

In Bojhe spring.

In Keshari Kharkha spring.



In Dhoje Dharapani spring.

Annex 2: Photographs

Kick-Off Workshop


समुन्नत शहर"

Figure 39: Images from FGD.

Figure 40: Image from HHS.